SCIENTIFIC AMERICAN SUPPLEMENT. No 1264

Scientific American, established 1845.
Scientific American Supplement. Vol. XLIX. No. 1264.

NEW YORK, MARCH 24, 1900.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

PREHISTORIC RUINS OF COPAN.*

GENERAL DESCRIPTION OF THE SITE.

WITHIN the territory of Honduras, about 12 miles from the frontier of Guatemala, in a beautiful valley watered by a rapid, winding stream, and shut in by mountains that rise in ridges to a height of 3,000 feet, are situated the ruins of Copan [lat. 14° 51′ 30″]. The only roads leading to the ruins are rough mule-tracks over the mountains; the shortest route from the Atlantic coast is that from Yzabel, crossing the mountain ranges of Mico and Espiritu Santo, between which the Motagua River flows in a circuitous course to the sea.

After leaving Comotan, the last town within the territory of Guatemala, to which the account given by Stephens in 1839 applies to-day, the road crosses the Copan River on its way to join the Motagua and ascends a mountain ridge, from whose summit glimpses can be caught of the stream, winding in and out between precipitous banks, tumbling over ledges, and leaping among the rocks, a perfect cataract, not navigable even to the lightest canoe. The road reaches a height of 2,800 feet, and then descends abruptly into the Copan valley, which has an elevation of 2,000 feet above the sea. The upper slopes of the surrounding mountains are covered with open pine forests, but the foothills and the plain of the valley are clothed in an impenetrable thicket of low trees and brush.

Stephens states that at the time of his visit, in 1839, the whole valley was buried in a heavy forest. Monkeys stared at him from the branches of the trees, and passed to and fro high above his head. To-day there are no monkeys in the vicinity, and the deep, gloomy forest where they like to roam is wanting.

According to information obtained from the oldest inhabitants of the modern village of Copan, the forest of gigantic trees that clothed the place in Stephens' day was cut down about 30 years ago by a colony from Guatemala, who came to plant corn and tobacco in the fertile lands of the valley. They left the trees that grew on the higher structures of the ruins, making a picturesque grove, a remnant of which still remains, a few cedars and ceibas of gigantic proportions, clustered about the ruins of the temples, shrouding them in a somber shade, and sending their huge roots into the crevices and unexplored chambers and vaults and galleries of the vast edifices. The valley in which the ruins are situated has the form of a level plain, about one and a half miles wide and seven or eight miles long, enclosed on all sides by the mountains, which rise in gentle slopes in front, and farther back in more precipitous ridges terminating in rounded peaks and level table-tops. The river flows in a southwesterly direction. It emerges by a narrow passage from the mountains, flows with many windings through the plain, and disappears through a gorge to the west. The principal ruins are situated on the right bank near the center of the valley, where the river runs close to the eastern foothills. Taking an abrupt bend to the west, the river flows directly against the ruins, by which its course is again turned abruptly to the south. As would be expected in a level valley like that of Copan, the river is constantly changing the position of its bed. For a long time it has been making encroachments on the ruins, and the entire eastern side of the great pile known as the Main Structure has been carried away by it, leaving the interior exposed in the form of a cliff one hundred and twenty feet high. The whole of this elevation is artificial; pieces of pottery and obsidian knives can be picked out of it even at the water's edge. The river is subject to annual freshets, during which an immense body of water is thrown with great force directly against the opposing cliff, from whose face a fresh portion falls in each succeeding year. So swift is the current that little of this fallen material is left when the water subsides.

STELA D AND HIEROGLYPHIC STEPS AT BASE OF STAIRWAY ON SOUTHERN SIDE OF MOUND 2.

FROM SUMMIT OF MOUND 20, LOOKING NORTHWEST.

Remains of building (21*a*) between Mounds 21 and 22. Mound 22 with ruined temple is at the left, and a part of the western side of Mound 21 at the right. A portion of the great plaza appears on the right in the middle distance.

HISTORICAL SKETCH.—Copan has been visited in former times by several travelers and explorers, who have given more or less accurate information respecting what they saw.

In 1530, Hernando de Chaves made an expedition into the neighborhood from the capital city of Guatemala, and conquered an Indian stronghold called Copan; but neither he nor any of his associates on the expedition left any account, so far as is known, of the people or towns.

In 1576, Diego de Palacio, Justice of the Royal Audiencia of Guatemala, traveling in accordance with his duties, passed through the ruins, and in a letter to King Phillip II. of Spain gives a description of what he observed.

From the time of Palacio's visit until the year 1835, a lapse of more than two and a half centuries, the ruins remained in total darkness, buried in the depths of a tropical forest, and unknown except to the indifferent natives, so that the historian

*From Monumental Records, by the courtesy of the Rev. Henry Mason Baum, D.C.L.

Robertson, writing in 1777, quotes the statement made to him that in all New Spain there is not "any monument or vestige of any building more ancient than the Conquest."

The report of Colonel Juan Galindo, who was commissioned by the government of Guatemala in 1834 to

MAIN STRUCTURE FROM EASTERN SIDE OF COPAN RIVER, LOOKING NORTH-NORTHWEST, SHOWING UNDERGROUND WALLS OF FACED STONE EXPOSED BY THE UNDERMINING ACTION OF THE RIVER FLOODS.

Mound 16 is at the left, and the summit of Mound 20 is seen at the right of the center of the illustration. The references here and throughout the article are to the plan. (See page 20258).

examine the ruins, has never been published in full, but a letter written by him to the editor of The Literary Gazette of London is printed in that journal for 1835, and a similar letter is printed in "The Transactions of the American Antiquarian Society," vol. ii.

These letters, although they make the ruins known for the first time to the civilized world, add little to our knowledge of Copan.

It remained for Mr. John L. Stephens, who, in 1839, was sent on a special commission to Central America by the President of the United States, and who, in his "chase after a government," improved his time by exploring the antiquities of the country, to awaken the general interest of the scientific world concerning the ruins.

Stephens was so fortunate as to have with him an English artist, Fred. Catherwood, whose pencil drawings, executed with most admirable fidelity, add greatly to the archæological value of Stephens' work.*

Owing to the dense tropical forest that hid the ruins of his day, the plan as well as the description by Stephens is of necessity incomplete, and in many particulars erroneous; he fell into an error that would seem to have been made by Palacio, nearly three hundred years before, in mistaking falling buildings for ruined city walls, and in denying the existence of interior chambers and stone-roofed structures.

The real character of the principal structure was first understood by Mr. Alfred P. Maudslay, of England, who prepared the first map of the ruins having any claims to exactness.

In 1885, Maudslay visited the ruins, and made the first attempt at an extensive and careful exploration. Having brought tools for excavating, and materials for taking impressions of the sculptured monuments, he made a number of excavations among the ruins,

* Incidents of Travel in Central America, Chiapas and Yucatan. By John L. Stephens. 1841, 2 vols., 8vo.

GREAT PLAZA, LOOKING NORTHWEST FROM SUMMIT OF MOUND 26, SHOWING FLIGHTS OF STEPS UPON EASTERN, NORTHERN, AND WESTERN SIDES, AND THE POSITION OF STELÆ AND ALTARS.

The western arm of the extension north of Mound 10 is in the foreground with Stela 2 at its southern base, and Altar L upon the level area forming its summit. Mound 4, excavated by Maudslay, is at the left of the center of the illustration, and a short distance in front is the fallen Stela 3. Stela A is hidden by Mound 4, and the fallen Stela 4 lies just beyond the Mound and near the circular altar. The broken Stela C and altar mark the center of the illustration. Stelæ B, D, F, and H are standing, and are designated by the letters near the lower margin of the figure. Fallen Stela E lies upon the terrace above the western range of steps just north of Mound 1.

and took with him to England a set of molds of the principal monuments, from which casts have been made and exhibited in the South Kensington Museum and in the Archæological Museum, at Cambridge.

The result of Maudslay's work, so far as relates to Copan, has been given to the world in a form which makes it at this date the most valuable contribution to the archæology of Central America.* In 1889, Mr. E. H. Perry obtained from the government of Honduras a concession with the object of founding a National Museum of Antiquities at Copan, to be under the management of a Society of Antiquarians, of which Mr. Perry was to be permanent president. The scheme involved the exploration of the ruins of Honduras, and the disposition of the collections thus obtained in a museum at Copan. The plan was never realized; and, in 1891, Mr. Charles P. Bowditch, of Boston, obtained from Mr. Perry all the rights pertaining to him through the above-mentioned concession, in the interest of the Peabody Museum of Archæology and Ethnology of Harvard University. The scheme outlined in this concession proved unsatisfactory, and a plan of operation was proposed to Gen. Luis Bogran, then president of Honduras, by which the interests of science would be better served, and which President Bogran, with a praiseworthy zeal for the promotion of scientific research, readily agreed to. The result was an edict of the government of Honduras, by which the Peabody Museum acquired the care of the antiquities of that country for a period of ten years, with the right of exploring and taking away one-half of the objects found in the excavations. The Peabody Museum thus acquired an unprecedented opportunity for making the investigations, so long delayed, but of such vast importance, that are needed to throw light on the early inhabitants of the American continent.

It was proposed to send an expedition to Copan each year, to remain during the dry season; and for this purpose a committee was appointed, consisting of Mr. Charles P. Bowditch, Mr. Francis C. Lowell and Prof. F. W. Putnam. The committee is indebted to Mr. Maudslay for valuable suggestions, which from his experience in exploring Central American ruins he is in a position to give, and through him also were obtained the services of skilled workmen who had been his assistants in making copies of the monuments.

The first expedition left Cambridge in October, 1892, in charge of Mr. Marshall H. Saville and Mr. John G. Owens, who had been Prof. Putnam's assistants in the museum, and under him had acquired a training that made them well fitted for the work. Being prevented by his duties from leaving Cambridge himself, Prof. Putnam directed the operations in the field by letters of instruction. The expedition was thoroughly equipped with tools for making excavations, and with materials for taking photographs and impressions of the monuments and other sculptures. Important results were obtained by the first season's work, which are referred to in the summary given further on.

The second expedition left in October, 1892, in charge of Mr. John G. Owens as director of the expedition, and also as a special commissioner for the World's Columbian Exposition. Mr. Owens took with him Mr. G. Byron Gordon as surveyor, and Mr. Edmund Lincoln and Mr. George Shorkley as assistants. Seldom has an archæological expedition gone to the field with such brilliant prospects, or under so energetic and enthusiastic a leader.

The party arrived at the ruins on the 1st of December, and for the first two months the work went on very satisfactorily. The principal part of the ruins were cleared of brush; a survey was being made; molds were made of all the monoliths that had not been molded in the previous year; several excavations were begun which gave most important results,

STELA 11, SHOWING HUMAN FIGURE.

and arrangements were made for obtaining molds of the great monoliths of Quirigua, in the coast region of Guatemala. It was to make these arrangements that Mr. Owens made a journey to the coast toward the end of January. Two days after his return he fell violently ill with a malignant fever of the country, and notwithstanding the efforts of a mind naturally cheerful, a constitution always robust, and a spirit never daunted, to cope with the violence of the disease, he grew rapidly worse, and died on the 17th of February, after 21 days of suffering. He was buried at the ruins, beside one of the great monoliths in the plaza.

Mr. Gordon then took charge of the work, and carried out, so far as possible, Mr. Owen's plans. Don Carlos Madrid, as representative of the Honduras government, was sent to Copan to take part in the division of the objects found; and those constituting the museum's share were transported to the coast and shipped to Cambridge. The molds of the Quirigua monoliths were completed, and from some of them casts have since been made.

In the winter of 1893-94, Mr. A. P. Maudslay went to Copan, as the representative of the Peabody Museum, and while there made several excavations, and brought back a number of molds. In October, 1894, a fourth expedition was equipped, and Mr. George Byron Gordon was appointed director. He arrived at the ruins in December, and was joined in March by Mr. Robert Burkitt, who was sent out with supplies. The party remained in the field until the end of June, 1895.

The route taken by these expeditions has been as follows: From New Orleans to Livingston in Guatemala, by the steamers of the Royal Mail Line; from Livingston to Yzabal by the steamer of the Rio Dulce Navigation Company; and from Yzabal to Copan by mules over the same route as was followed by Stephens in 1839. At Yzabal the members of each expedition have been placed under deep obligation to Mr. and Mrs. Potts, the only American people living at that place. Mr. Potts, from his intimate knowledge of the country, acquired during a residence of over thirty years, and from his interest in its antiquities, as in all matters relative to scientific research, has been able to render most valuable services, and the museum has been glad to avail itself of his kind co-operation. The members of these expeditions will always cherish the memory of those happy occasions at his hospitable board, when, after long and weary journeyings and months of hardship and exposure, they were made so welcome there, and so tenderly cared for by the kindest of hostesses, Mrs. Potts.

In Livingston valuable services were rendered to the first expeditions by Mr. John T. Anderson, who was then consul of the United States at that port. The later expeditions are greatly indebted to Mr. William Owen, manager of the Northern Transportation Company at Livingston, and also to Mrs. Owen, who extended such kindly hospitalities to the members of the expeditions as to win their lasting gratitude.

DETAILED DESCRIPTION OF THE RUINS.

The plan shows the central group of ruins and the contiguous parts. The nomenclature of the different parts so far as given by Maudslay has been adopted. The principal ruins are grouped about what has been called the main structure, a vast irregular pile, rising from the plain in steps and terraces, and terminating in great terraced elevations, each topped by the remains of a temple. [See plan 11, 16, 20, 21, 22, 26.] The summit of the highest of these is about 130 feet above the level of the river. Of the temple (the same number is used to designate a mound or the temple on its summit) with which each of these elevations was crowned only the foundations and parts of the lower walls now remain in position. The place where each stood is a heap of fragments, and the slopes of the pyramids and the terraces and pavements below are strewn with the ruins of these superb edifices. The walls of the buildings and the outer casing of the pyramids and terraces are built of stone, neatly cut in flat-faced oblong blocks, and laid in parallel rows, occasionally with mortar, but generally without. All these stone walls and casings appear to have been plastered, and the plaster decorated with paintings; but only slight traces of these remain.

NORTHEASTERN SLOPE OF MAIN STRUCTURE, LOOKING SOUTHWEST, SHOWING, NEAR CENTER OF ILLUSTRATION, THE ELEVATIONS UPON WHICH STAND TEMPLES 21, 21A AND 22.

To the right is Mound 26, and to the left is Mound 20 overhanging the river front. The stone wall in the foreground was built by the Peabody Museum Honduras Expedition for the protection of the ruins.

* Biologia Centrali-Americana, edited by F. Ducane Godman and Osbert Salvin. Archæology, by A. P. Maudslay. Parts I. to IV.

Little attention seems to have been given to breaking joints in the stone work; and while generally some care seems to have been taken to prevent the joints in contiguous rows from falling together, no definite system of breaking joints was adhered to. This is rather surprising when we consider the nicety with which the blocks were cut, and the perfect regularity of the rows. The slopes of the pyramidal foundations are built in terraces about 5 feet high and 5 feet broad, or in steps consisting of single or double rows of stones, the step or terrace being generally, if not always, covered on top with a layer of mortar cement.

The interiors of all the raised foundations and pyramids, so far as known from excavations made, are filled with rough stones and clay, which shows signs of having been very carefully laid for solidity and strength. It is not unusual to find in the interior of the pyramids a second casing, or at least secondary walls and terraces; but whether these form in any instance complete interior casing, or whether they are confined to one side or part of a side, has not been determined. The question of their meaning has been complicated by the discovery of similar walls below the foundations of some of the pyramids. These underground walls can best be seen on the river front, where the face of the exposed cliff formed by the action of the river presents patches of faced wall more than half way down. It was probably the existence of these walls that led to the erroneous belief in what has been called the great wall of Copan.

Mr. Maudslay seems to have been of the opinion that the object of these interior walls was to strengthen the structure and bind it together. But the conditions under which they were found seem to preclude this theory from general application, although it may very well apply to particular cases.

Mr. Owens, who gave a good deal of attention to the problems presented by the river front, was inclined to believe that these underground walls marked different stages in the development of the structure, and were in fact the remains of older buildings that had been occupied for a time, and abandoned in the gradual building up of the great complex structure to its ultimate form. The cause of this abandonment of buildings now beneath the foundations of others can be readily ascribed either to the changing tastes and requirements of the people, or to the pride of rulers for whose glorification the works and dwellings of their predecessors had to be sacrificed to give place to temples in their honor. There is some actual evidence in the condition of the buildings, as we find them on the surface, to support the theory of a gradual alteration in the shape and size of the buildings: Temple 50 was built against the side of Pyramid 16, its wall resting on the terraces. In the eastern end of Temple 22 a doorway was found walled up. Two lower chambers in Temple 20 were found filled with clay and rubble, and their doorways closed by walls. All this would seem to indicate a gradual addition of new features accompanied by abandonment of older parts. It can readily be seen how a process of this kind carried on for centuries, without any well designed plan to adhere to, or in any definite idea to carry out, would result in a great complex mass of structures like that of Copan to puzzle and perplex the explorer.

There are other evidences that point to several successive periods of occupation. The river front presents what looks like at least three great strata, divided by floors or pavements of mortar cement. If these floors mark the various levels corresponding to different epochs in the history of the city, the question of the age of the ruins becomes still more complicated; for between each successive period of occupancy there is the period of silence, the length of which can only be inferred from the thickness of the superimposed stratum. The questions thus raised by the results of the first investigations can only be settled after extended exploration and study.

In the interior of the Main Structure are two enclosed courts, their floors, paved with mortar cement, being 65 feet above the level of the river. One of these, the Eastern Court, is entered from the south by a narrow passage, between mounds 16 and 18, formerly closed at its southern end by a thick wall, now broken down in the center. The sides of the court are built up with solid stone work in seats or terraces as in an amphitheater. About the center of its eastern side the terraces have been torn away and a deep pit made underneath, revealing the end of a tunnel which leads to the vertical face of the cliff overhanging the river. This pit also gives access to a small chamber directly beneath the inner end of the tunnel. The following is quoted from Maudslay [page 31]:

"Palacio in his description mentions the 'two caves or passages' the openings of which can be seen on the face of the river wall, and which have given to the ruins the name of 'Las Ventanas,' or 'The Windows.' . . . The floor of the passage is level, and the interior is faced with stone, and is just large enough for a man to crawl through. The top of the passage is a little below the level of the court; it was closed on the land side, and I think not intended again to be opened. A deep pit was dug here by Colonel Galindo, shown in the plan, which now gives access to the passage.

"A few feet from the end of this passage, but at a greater depth below the level of the court, is the subterranean vault, . . . which was broken into by Colonel Galindo. The vault and passage do not seem to have had any connection with one another. The following is Galindo's description of his discovery:

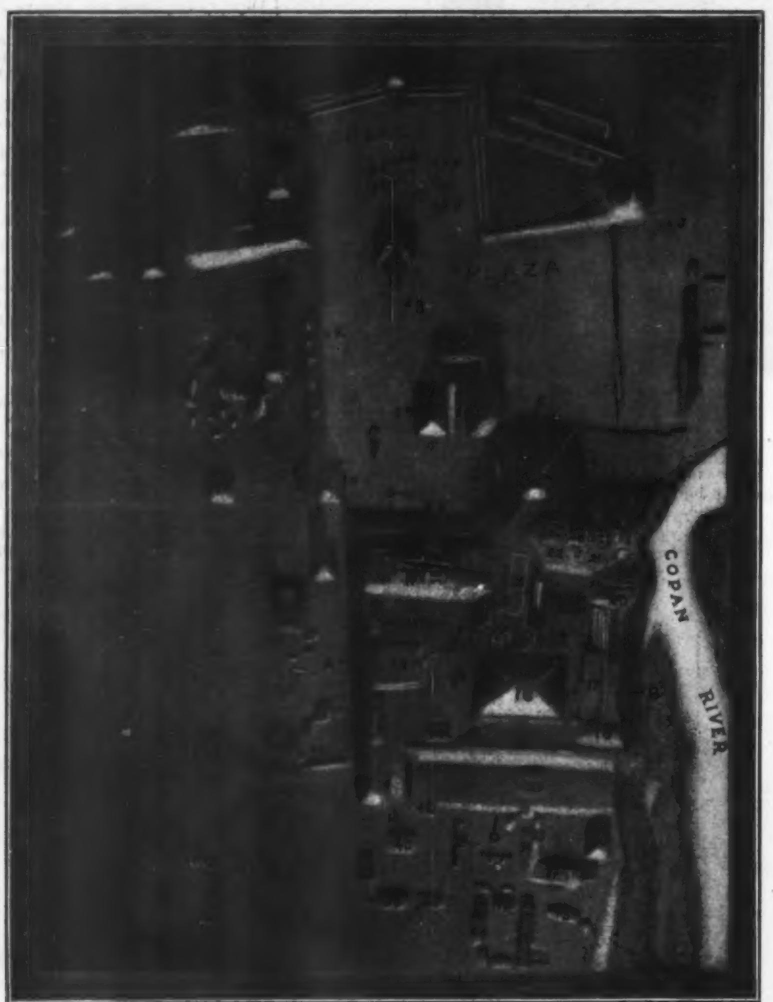
"'Through a gallery scarcely 4 feet high and 2½ feet broad one can crawl from this square through a more elevated part of the temple overhanging the river, and have from the face of the precipice an interesting view. Among many excavations, I made one at the point where this gallery comes out into the square. I first opened into the entrance of the gallery itself, and digging lower down I broke into a sepulchral vault whose floor is 12 feet below the level of the square. It is more than 6 feet high, and 10 feet long, and 5½ feet broad, and lies due north and south, according to the compass. It has two niches on each side, and both these and the floor of the vault were full of red earthenware dishes and pots. I found more than fifty, many of them full of human bones packed in lime; also several sharp-edged and pointed knives of chaya (a brittle stone called itztli by the Mexicans), and a small head, apparently resembling death, its eyes being nearly closed and its lower features distorted. The back of the head is symmetrically perforated by holes; the whole is of most exquisite workmanship, and cut out or cast from a fine greenstone, as are also two heads I found in the vault, with quantities of oyster and periwinkle shells brought from the seashore in fulfillment of some superstition. There were also stalactites taken from some caves. All the bottom of the vault was strewn with fragments of bones, and underneath these a coat of lime on a solid floor.'

"There is another similar passage lower down the cliff and farther to the north. We made a ladder and succeeded in entering this passage and crawling to the further end, which we found closed with a stone wall. It is about the same length as the first passage described."

All the accounts of this tunnel contain several errors. Its real dimensions are: Height, 3 feet; breadth at bottom, 2½ feet; length, 65½ feet. The floor is not level, but has a downward slope toward the river of about three feet in the whole length, the floor at the inner end being on a level with the floor of the court.† . . .

On the slopes of the foot hills on the eastern side of the river are a number of ruined stone houses, and on the top of a table mountain, called Albonete, to the northeast, whence a fine view of the ruins is obtained, there are some scattered remains of stone work. On the slope of a mountain to the east at a distance of 1·50 miles from the river, are the remains of a stone structure of some kind, and the fallen and broken Stela 12, with an inscription on each of its four sides. 2·75 miles to the west is a mountain peak commanding a splendid view of the whole valley; on its summit is Stela 10, fallen and broken; this is similar to the one on the east. A line joining these two stelæ passes very close to the southern slope of the main structure (see line indicated by arrows, *a b*, on plan), and bears N. 86° 46′ west (magnetic.)*

The quarters from which the stone was taken for the monuments and buildings are in a ridge to the northwest. The rock is a trachyte, and outcrops along the ridge in abrupt ledges. Deep excavations are to be seen, and large quantities of chips and flakes are found, together with some quarried blocks. Several detached stelæ are found at different points of the valley. They are all fallen and broken, and much less elaborate and striking in appearance than those in the great Plaza.† . . .



PLAN OF THE PREHISTORIC RUINS OF COPAN.

From photograph of the relief model in the Peabody Museum of Harvard University, Cambridge. *A, B, C, D, E, F, H, I, J, K, L, M, N, O, P, Q*, 1, 2, 3, 4, monolithic monuments (stelæ and altars) sculptured in relief. 7–10, 13, 14, 29, 33, 34, 37–40, 43–49, 51–56, small mounds, mostly unexplored, composed principally of the débris of ruined stone buildings and their foundations; 11, 16, 20, 21, 21*a*, 22, 32, 41, 50, ruined temples, situated mostly on high artificial elevations. These have been partially or wholly explored. *A*–, –*B*, *C*–, –*D*, *E*–, –*F*, *G*–, –*H*, refer to cross-sections of the main structure.

ICE BREAKERS IN POLAR EXPLORATION.

By Edwin Swift Balch, in Journal of the Franklin Institute.

Polar exploration, if divided in accordance with the ships employed, may be classified into three periods. The first covers four centuries, from the great voyage in 1596 of the pioneer, Willem Barentz, of Holland, to the building of the "Fram." During this period, ships were almost defenseless against the Arctic ice, and when they were pushed into it, they practically lost all means of independent locomotion, even after the advent of steam. They would be crushed or stay on top, in accordance with the movements of the ice, and in utter disregard of the wishes of the men on board. Curiously enough, however, no one seems to have given any thought to the models of ships for polar exploration. Any old ship was considered suitable for the purpose, after she had received some extra strengthening. Whaling and sealing vessels were not constructed on the best lines to resist ice pressure, for their main object was to permit the stowage of large quantities of oil. Experience gradually fostered the belief that no ship could be devised strong enough to resist a real pressure from the ice in the winter months, even if it might be fortunate enough to escape in the summer ones.

The second period begins and ends with the voyage of the "Fram." This reversed all previous notions on the subject, and proved conclusively that a ship can be built of sufficient defensive power against ice floes, to drift in safety across the Arctic Ocean. The "Fram" was designed‡ with the idea of making "the shape of the hull such as to offer as small a vulnerable target as possible to the attacks of the ice;" and to build her "so solidly as to be able to withstand the greatest possible pressure from without in any direction whatever." To accomplish these aims, she was built with extremely sloping sides, which enabled her to rise in response to every increase of ice pressure. When the pressure became great, the "Fram" was lifted by the ice and rode on top of it; until, with a diminution of the pressure, the weight of the ship caused her to settle down again.

The third period may be said to begin with an address delivered some time in 1898, before the Russian Geographical Society, by Vice-Admiral Makaroff, of the Imperial Russian Navy, in which he proposed to reach the pole by means of ice breakers. An abstract of his paper was published in The Geographical Journal for October, 1898. He succeeded in having a large ice breaker built, not for Arctic traveling, but for commercial purposes, and the story of this ice breaker is told at length in The Geographical Journal for January, 1900.

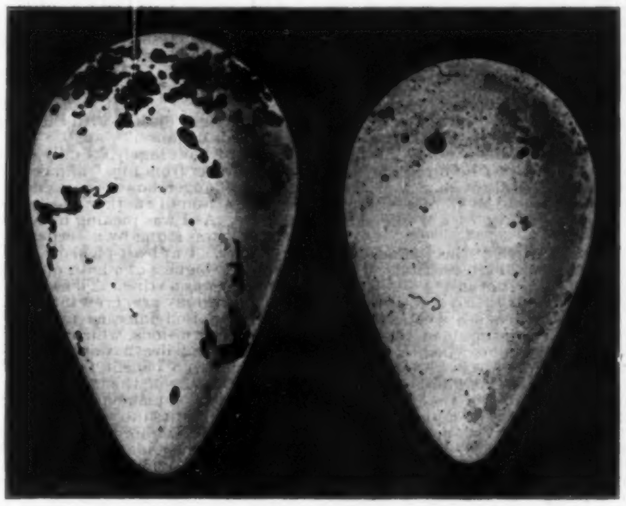
The "Yermak" was built in England by Armstrong, Whitworth & Company, according to the designs of Admiral Makaroff. She was intended to clear the way

* The magnetic declination at Copan was found to be 6° East.

† For a further detailed description of the ruins and illustrations see Peabody Museum Memoir, Vol. I., No. 1, from which the above is an abstract.

‡ "Farthest North," by F. Nansen, Vol. I.

in the winter time through the ice to the port of St. Petersburg, and in summer time to help the navigation to the Siberian rivers flowing into the Kara Sea, barricaded by ice almost during the whole summer. She is a steel ship, with a double bottom and double sides, and is divided into forty-eight compartments. She is 305 feet long, and 71 feet broad. With 3,000 tons of coal aboard, her displacement is 8,000 tons, and in this condition she draws 25 feet. Her bow is inclined 70° from the vertical; her stern is 65°, and her sides are 20° from the vertical. In whichever direction she



TWO AUK EGGS. (Two-fifths natural size.)

moves in the ice, she is bound to rise on it and break it with her weight. She has four engines, working four independent propellers, one in front and three at the stern. Each engine develops 2,500 horse power, so that the total force of the engines is 10,000 horse power. Each propeller is supplied with an extra auxiliary engine, so that the main engine can be disconnected if necessary; this was meant to save fuel under certain conditions.

The "Yermak's" maiden voyage was from Newcastle to St. Petersburg in the winter time, on which occasion she forced her way with ease through 160 miles of ice. In June, 1899, under the command of Admiral Makaroff, she was given a trial in the polar ice west of Spitzbergen. After this, she steamed back to Newcastle, where she was strengthened and the forward propeller taken out. On August 6, she again entered the polar ice north of Spitzbergen. This time she was in the ice two weeks, "covering in that period 230 miles in eighty-seven hours."

No attempt was made at exploration, although it is believed that land was discovered to the northeast, as evidenced by the refraction of the air. The time was devoted to studying the ice, the ship herself, and her behavior in the ice. The trip was, in fact, a shipbuilder's trial trip. In heavy ice where there was considerable pressure, it took four hours to make 2 miles. In moderately thick ice, the ship made 2½ miles or more an hour. It was found that the conditions of the ice were so different in the Baltic and in the Arctic, that to get the best results in the latter, a special ship would have to be constructed. Admiral Makaroff came to the conclusion that strength of construction was the main point and that even the "Yermak" was not strong enough, but that the engine power could be reduced without disadvantage; in fact, he thought 2,500 horse power would be sufficient for fairly good progress through the ice. The room gained by reducing engine power could be utilized to carry more fuel, and about this it was also concluded that liquid fuel would be preferable in all respects to coal.

These experimental voyages of the "Yermak" prove conclusively, what was never suspected before, that a vessel may be constructed of sufficient offensive power and sufficient defensive power to force her way through the Arctic pack. The problem of how to penetrate the unknown regions of the Arctic and of the Antarctic appears solved at last. It means discarding the old methods of wooden vessels, sledges, dogs, etc., wherever the sea extends and adopting the resources of the modern naval engineer, of steel, steam, and electricity. The change is complete, and the results may prove a lasting benefit to scientific geography.

THE GREAT AUK.*

By GEORG KRAUSE.

As the century is nearing its end, it would not be out of place to describe one of its most remarkable animals—a bird which disappeared two generations ago. The bird I refer to is the Great Auk or Gare-Fowl (Alca impennis, L.), the largest representative of its still living northern relatives. Fortunately its extinction proceeded gradually—so gradually, in fact, that it may be said to have occurred under the very eyes of scientists.

Great Auks were imposing birds of the size of a goose; in color they were black and white. Their most remarkable feature was their small wings, which rendered them incapable of flying. On land they waddled along in a pitiful way; but in water, they moved about with the utmost facility. Like most other members of the family they were markedly gregarious. This tendency to congregate proved their misfortune, for soon the few islands were discovered to which they annually flocked at breeding time from all parts of the Northern Atlantic coast. They were slaughtered by thousands; and their eggs were collected and sold as delicacies. When it is considered that the female bird laid but one egg in a year, it is readily conceivable that complete extinction would soon follow from indiscriminate destruction. In spite of the ravages made each year, the birds, owing to their great number, resisted extinction for several centuries.

The earliest account of the Great Auk which has come down to us is probably that of Olafson, who, in 1458, visited Iceland, and found that twenty-five miles from Reykjanes was a cliff upon which whole boatloads of auk eggs could be gathered. In 1534 two boats from Cartier's ships landed at Newfoundland. In less than half an hour, we are told, the two boats were filled with eggs, as if with so many stones. Each ship pickled from five to six casks of the eggs. In a letter dated November 13, 1578, Hakluyt describes the incredible number of auks on Penguin Island, and states that the French sailors killed and salted enormous numbers of the birds. At the beginning of the nineteenth century gradual extinction began. There were only a few scattered flocks of birds left. In 1818, a ship touched at the "Geierfuglskjär." According to one account, twenty, according to another, twenty-four brooding Great Auks were killed. Since the birds had become rather valuable owing to their decreasing numbers they were brought to Reikiavek. In 1815, Holböll states that the last Great Auk, under latitude 64°, was caught near Fiskernœs; in 1830, the Geierfuglskjär, as a result of volcanic action, sank beneath the waves and buried with it the last important breeding place of the auks. The homeless birds seem all to have taken refuge on a small island, called Eldey Island; for Goumundson here captured twenty-one birds, which were for the most part preserved for scientific purposes. In 1831, Goumundson captured twenty-ty-four auks, some of which he brought home with him alive. Eldey Island is very conveniently situated; and it naturally followed that in fourteen years the few auks still remaining were exterminated. In 1832, ten birds were captured; in 1833, thirteen; in 1834, nine; and between 1840–41, only three. In 1844 the last two were caught and killed.

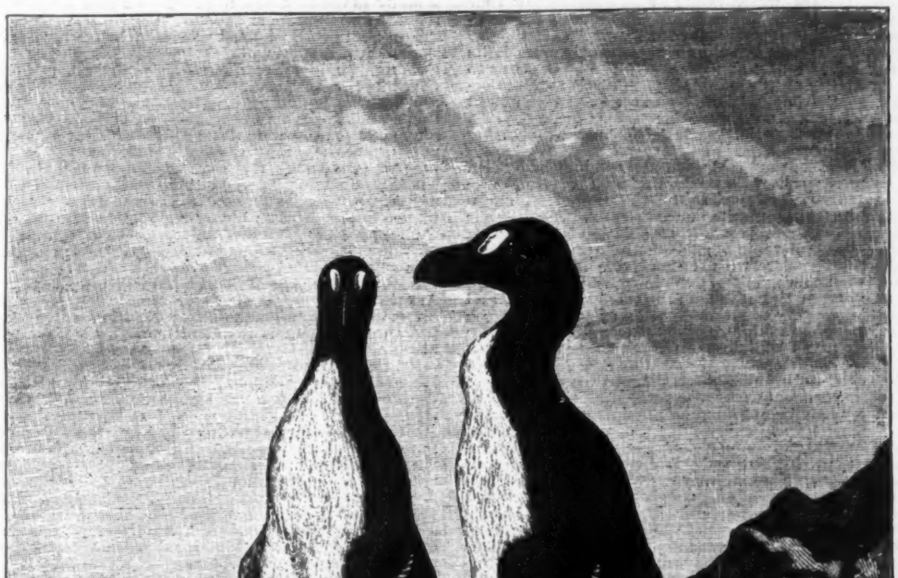
It was on a windy morning on the third of June, 1844, that fourteen seamen rowed to Eldey Island. From the shore, the beach rose in an incline to a steep bluff. From this incline the auks could easily reach their breeding place on the cliff. Newton has very minutely described the capture of the last pair of auks. Only three men landed from the boat. Their names were John, Ketil, and Sigurd. Hardly had they stepped ashore when they spied among the vast number of seabirds perching on the cliffs two Great Auks. A pursuit was immediately begun. With their heads stretched forth and their wings hanging down, the birds ran along the shore under the overhanging bluff. Silently they fled from their pursuers, their webbed feet pattering on the rocks. John drove one of the auks into a corner and caught it as he would a goose. The other two sailors succeeded in capturing the remaining bird after it had been forced against the rocky wall of the cliff. Ketil returned to the spot where the auks had first been seen and spied, lying unprotected on a block of lava, an egg which he immediately recognized as that of an auk. He picked it up, saw that it was addle, and cast it away. Quickly the three men hastened back to their boat; for the wind was rapidly rising. The two auks, the last of the species, were strangled and afterward sold for $45.

Fortunately our museums have still many specimens of the extinct bird. According to the list compiled by Blasius, in 1883, there are in various collections seventy-four specimens (not including complete skeletons and individual bones), as well as about two hundred eggs, most of which are preserved in private collections in England. These relics have acquired an enormous value. Not long ago a skeleton brought $600; and a skin $650. In April, 1897, a single egg was sold for 280 guineas. Thus are treasured the remains of a species of birds which were once ruthlessly slaughtered by thousands.

* From the Illustrirte Zeitung.

SCIENCE BREVITIES.

THE amount of wood necessary to furnish paper for one day's issue of a big newspaper is thus estimated by Prof. G. H. Prescott, according to Popular Science News: "A cord of spruce wood is equal to 615 feet board measure, and this quantity of raw material will make half a ton of sulphite pulp, or one ton of ground wood pulp. Newspaper stock is made up with 20 per cent. of sulphite pulp and 80 per cent. of ground wood pulp. The best known spruce land, virgin growth, possesses a stand of about 7,000 feet to the acre. Twenty-two acres of this best spruce land will therefore contain 154,000 feet of timber. An average gang of loggers will cut this in about eight days. This en-



TWO EXTINCT GREAT AUKS.

tire quantity of wood turned in at any one of the large mills will be converted in a single day into about 250 tons of such pulp as goes to make up newspaper stock. The pulp will make about an equal weight in paper, which will supply a single large metropolitan newspaper just two days, so that newspapers as well as builders have a practical interest in forestry."

REMEDIES FOR SNAKE-BITE: SCIENTIFIC AND EMPIRIC.

By A. W. Buckland.

For some years past Prof. Frazer, of Edinburgh, M.D., F.R.S., and Dr. A. Calmette, of the Institut Pasteur, Lille, and others, have been engaged in the very laudable endeavor to discover a reliable remedy for snake-bite. This they believe has been found in the poison of the reptile itself.

When we reflect that in India alone more than 20,000 people die annually from the effects of snake-bite, the extreme importance of an easily applicable remedy cannot be over-estimated. Whether the antivenine proposed as this remedy by Drs. Frazer and Calmette will ever become generally useful time alone will show; it is at present in the experimental stage, and although the results appear to give great hope for the future, it must be many years before it can be so employed as to make any sensible diminution in the number of victims.

The system adopted by these learned doctors is that of Pasteur, the scope of which, since its first inception, has become so widely extended as to embrace many diseases formerly regarded as incurable, but now found to be more or less amenable to the new treatment, which consists of inoculation with attenuated virus of the disease itself, or with the blood serum of animals which have been immunized by the process, the treatment being employed not only as a cure, but as a prophylactic.

In the case of snake-bite the remedy consists in the subcutaneous injection of gradually increasing doses of the venom of deadly snakes until the animal treated becomes proof against the poison, the blood serum of an animal thus immunized, known as antivenine, or of the snake itself, being to cure or protect others. The animals thus treated have been chiefly rabbits, rats and pigeons, and it is asserted that instead of being injured or weakened by the experiments, they gain in weight and vigor.

The doses administered have been proportioned to the weight of the animal, and four methods of administration have been tried experimentally. In the first the venom and the antivenine were mixed together before injection; in the second the two were administered separately but simultaneously; in the third and fourth the antivenine was injected before and after the venom. The latter is, of course, the only method applicable to actual cases of snake-bite, and it is of special interest to know how long after the bite antivenine may be relied on as a remedy, because the poison of the more deadly of the snakes acts so quickly that no remedy can avail unless close at hand. In some of Dr. Calmette's experiments serum injected an hour, and even an hour and a half, after a large dose of venom seems to have effected a cure, which would at all events allow time for the application of the remedy should any one competent to administer it be near at hand.

But undoubtedly the chief value of antivenine is its protective influence; and here the question arises as to the durability of the immunity acquired by the injection of snake venom, or the blood serum of immunized animals; this has not as yet been ascertained, but Dr. Frazer found it perfectly efficacious in a rabbit after twenty days.

Some very curious experiments conducted by Dr. Frazer tend to show that immunization may to a certain extent be conveyed to the offspring of an immunized animal through the mother's milk. A cat, while undergoing the process of inoculation with cobra venom and antivenine, gave birth to kittens which, while still fed solely with the mother's milk, were injected with cobra venom. One, when fifty-seven days old, was given twice the minimum lethal dose, and showed only very slight symptoms of poisoning; the other, when sixty-nine days old, succumbed to thrice the minimum lethal dose of poison, the mother's milk not being sufficiently antitoxic to so large a dose of venom, although sufficing for the smaller dose.

This experiment is of great value as showing that immunity may be obtained by administration through the stomach as well as by subcutaneous injection, and that the milk of immunized animals is powerfully antitoxic. Dr. Frazer, indeed, believes that serpent venom, although apparently inert when taken internally, may really produce immunity, and it is to this point that I would particularly direct attention, because it would appear that some of the lower races have long been accustomed to use the venom of the serpent as an antidote, having thus ignorantly anticipated the discoveries of modern science, and the object of this article is to show the various remedies resorted to by non-scientific folk in various parts of the world for the cure of or protection against snake-bite. Most of these are empirical and mingled with curious superstitions, but some are of undoubted value as curative or protective agents.

It has long been suspected that Indian snake charmers have some means of rendering themselves immune to the bite of the reptiles they handle so fearlessly, and it was this supposed immunity, added to the widespread belief that venomous serpents are protected against the venom of their own and other species of serpents which led to Dr. Frazer's experiments.

Nevertheless, we hear from time to time of snake charmers being killed by the reptiles they handle, and of snake fights in which the vanquished succumbs to the venom of the victor; but these instances are comparatively rare, and in the case of the man may be the result of some laxity in the application of the preventive agent, whatever that may be.

It is generally supposed that the serpents exhibited by snake charmers have been deprived of their fangs, and this is doubtless often the case, while one instance at least is recorded in which the mouth of the snake had been sewed together to prevent it from biting. The writer noticed at the Ceylon exhibition, given some years ago in London, that one of the snake charmers, finding the cobra he was exhibiting becoming too lively and aggressive, seized the reptile by the neck and thrust it hastily into the small round basket in which it was carried, at the same time pushing it with a voluminous white cloth at which it bit savagely. Having almost closed the lid of the basket, the man drew away the cloth violently, thus doubtless dragging out the fangs which were fastened in it; he then secured the basket and carried it away. This, of course, required a large amount of cool courage as well as great quickness of hand and eye, all of which qualities must be doubly necessary in capturing and taming these deadly reptiles.

But if we are astonished at the skill and dexterity displayed by Indian snake charmers, still more must we marvel at the hardihood of the American Indians, who, in their snake dances, not only handle the deadly rattlesnake with impunity, but absolutely carry it about in their mouths.

There is reason to suppose that in both hemispheres those who handle these venomous reptiles have found some means of rendering them innocuous. What this means is has yet to be discovered; but probably in some cases it consists of anointing the body with some preparation distasteful to snakes. Navarette, a Spanish monk, writing of the Chinese Empire at the beginning of the last century, says of the snake charmers:

"They said those that carried the snakes were anointed with the juice of several herbs, so that, though they bit, they could do them no harm."

It has often been noticed that the snakes turn their heads away from the charmer, and appear sick and disgusted, and it can hardly be doubted that these reptiles are affected by certain odors which are repellent to them. Hence a piece of deer-skin is said to afford protection to the wearer, but whether that applies to all deer-skin, or only to that of the musk deer, is not specified.* Some natives drag a piece of deer-skin between their toes in walking as a protection, and they have doubtless proved its efficacy.

A nearer approach to the remedies of Dr. Frazer was given in the discussion of this paper, by Prof. Stovkis, of Amsterdam, who said that "in the Dutch colonies it is customary for the snake catchers to prepare themselves, before starting, by rubbing all over their skin a powder made from the dried head of snakes, with their poison-glands. As a result of this precaution they either are not bitten, or they are rendered immune against the effects of bites."†

But immunity is also sought, and probably obtained, by the ingestion of poisons, and it is a noteworthy fact that the little Bushman, low as he is in the scale of humanity, has to some extent anticipated Dr. Frazer's experiments, for he boldly swallows the poison bag of the cobra and other venemous snakes, believing that he can thus protect himself from their bite.‡ In The Graaff Reinet Advertiser for June 25, 1896, it is stated that Dr. Laurence, of Cape Colony, knew a Kaffir boy (age 25) who could handle the most deadly snakes, suffering them to bite him with impunity, which he said was owing to the fact that when a child, while playing in the veldt, a puff-adder fastened on his leg; he called to his father, who killed the puff-adder and removed the poison glands. He then made little pellets of mud, dipped them in the poison, and administered one occasionally to the boy, which cured him and apparently rendered him immune.

The aborigines of Australia are fearless hunters of snakes, which they will dislodge from high trees, and, although we do not read of their swallowing the poison bag, like the Bushman, they greedily devour the whole reptile, even pounding up the bones and swallowing them, and in this way they may, perhaps unintentionally, acquire protection from the bite. But vegetable poisons are those most generally employed for the purpose of preventing the deadly effects of snake-bite. These are commonly named snake weeds or snake roots, and are sometimes chosen from some fancied resemblance to the reptile; but according to Miss Gordon Cumming, the "Tamil coolies are said to eat a small portion of the nux vomica bean daily as an antidote against snake-bite."‖

Neibuhr, treating of Arabian medicines, says that Aristolochia semper virens is used as a cure and preservative from snake-bite. If this be drunk for forty days, a man is in no future danger from being bitten.

Dr. Schliemann relates that during his excavations at Hissarlik, where poisonous snakes were found among the stones as far down as from thirty-three to thirty-six feet:

"I had hitherto been astonished to see my workmen take hold of the reptiles with their hands and play with them; nay, yesterday I say one of the men bitten twice by a viper without seeming to trouble himself about it. When I expressed my horror he laughed, and said that he and all his comrades knew that there were a great many snakes in his hill, and they had, therefore, all drunk a decoction of the snake weed which grows in the district, and which renders the bite harmless. Of course, I ordered a decoction to be brought to me, so that I also may be safe from their bites."

But he adds:

"I should, however, like to know whether this decoction would be a safeguard against the fatal effects of the bite of the hooded cobra, of which in India I have seen a man die within half an hour."§

So far the remedies of which we have treated must be classed under the head of prophylactics, their use being intended to prevent rather than to cure, and among these it will be seen that, to a certain extent, the ignorant savage and untaught peasant have anticipated the scientific remedy of the Edinburgh professor in employing the venom of the snake to counteract itself.

When, however, we come to remedies, or supposed remedies, for the actual bite, we shall find some possessing more or less therapeutic value, while others belong wholly to empiricism and superstition.

There is a story told by Lobo, the Jesuit traveler in Abyssinia (1622), which is a good illustration of the superstitions relating to serpents current in his day, and the remedies for snake-bite then in vogue:

"I was," he says, "in great danger of my life, for, as I lay on the ground, I perceived myself seized with a pain which caused me to rise, and saw, about four yards from me, one of those serpents that dart their poison at a distance; although I rose before he came very near me, I yet felt the effects of his poisonous breath, and if I had lain a little longer had certainly died. I had recourse to bezoar, a sovereign remedy against these poisons, which I always carried about me. These serpents are not long, but have a body short and thick, and their bellies speckled with brown, black, and yellow. They have a wide mouth, with which they draw in a large quantity of air, and, having retained it for some time, eject it with such force that they kill at four yards distance."*

Then he adds sagely," I only escaped by being somewhat farther from him," and continues:

"This danger, however, was not much to be regarded in comparison of another which my negligence brought me into. As I was picking up a skin that lay upon the ground I was stung by a serpent that left his sting in my finger. I at least picked an extraneous substance about the bigness of a hair, out of the wound, which I imagined was a sting. This slight wound I took little notice of till my arm grew inflamed all over; in a short time the poison infected my blood and I felt the most terrible convulsions, which were interpreted as certain signs that my death was near and inevitable. I received now no benefit from bezoar, the horn of the unicorn, or any of the usual antidotes, but found myself obliged to make use of an extraordinary remedy, which I submitted to with extreme reluctance."

What this extraordinary remedy was we are not informed, but he adds:

"This submission and obedience brought the blessing of Heaven upon me; nevertheless, I continued indisposed a long time, and had many symptoms which made me fear that all danger was not yet over. I then took clover of garlic, though with a great aversion from the taste and smell. I was in this condition a whole month, but at length youth and a happy constitution surmounted the malignity and I recovered my former health."†

In this narrative we are introduced to two species of serpent unknown to zoologists, and to several remedies which would be scorned by science; nevertheless one of the remedies held its own for a long series of years, and it is doubtful whether it is yet wholly discarded.

The bezoar or bezoars, for there are several kinds, were so highly valued that they were often encased in gold, and handed down as heirlooms. The Encyclopædia Britannica, eighth edition, has a long article upon them, but the word does not appear in the ninth edition, probably because the scientific editor regarded it as among lapsed superstitions. Glancing at the description given in the encyclopædia we find the bezoar described as a calculous concretion found in the stomach of certain animals of the goat kind, composed of concentrical coats having a little cavity in the center containing a bit of wood, straw, hair, etc. This is evidently such a substance as is frequently found in the stomach of ruminant animals, but it does not tally with the bezoar described by Lord Lytton in his "Strange Story" as used in Corfu by the peasants, and which had never been known to fail but once, and then it had not been used until after the lapse of twenty-four hours. This was a stone almost black in hue, which was applied to the wound caused by the bite of a venomous snake, to which it adhered, absorbing the poison and falling off when saturated. It was then thrown into milk, when it disgorged the poison, which appeared as a green scum floating on the milk. When dry it was again ready for use. This was, doubtless, an Oriental bezoar, which is more esteemed than the Occidental, the latter being rougher, lighter in color, and larger, sometimes as large as a goose's egg, whilst the Oriental is seldom larger than a walnut.

Dr. Johnson derives the name bezoar from the Persian words pa (against) zahar (poison), and describes it as "a medicinal stone formerly in high esteem as an antidote, and brought from the East Indies, where it is said to be found in the dung of an animal of the goat kind called pazan, the stone being formed in its belly, and growing to the size of an acorn, and sometimes to that of a pigeon's egg. Its formation is now said to be fabulous. The name is applied to several chemical compositions designed for antidotes; as mineral, solar, and jovial bezoars."

That bezoars were often manufactured is certain, as also that they were employed as antidotes to poison in any form; those dominated jovial being, doubtless, used to detect and destroy poison in the wine cup, but it was as the serpent-stone that they were chiefly famous. Sir Emerson Tennant described some of these, black and highly polished, as used in Ceylon for the cure of the bite of the cobra.

The common and well-nigh universal use of these bezoars seems to prove that there was some efficacy in them, when properly prepared, so as to be highly absorbent; but superstition soon seized upon the "serpent-stone," and gave its name to every stone which had upon it little cavities whether absorbent or not; hence the serpent-egg of the Druids, glass beads, and those spindle-whorls known as pixies' wheels, were all accredited with the properties of the bezoar, while the mysterious origin of the famous nostrum gave rise to innumerable fables. Avenzoar, an Arabian physician, describes it as generated of the tears of stags, who, after eating serpents, used to run into the water up to the nose, where they stood till their eyes began to ooze a humor, which, collecting under the eyelids, gradually thickened and coagulated, till, being grown hard, it was thrown off by the animal in rubbing frequently. It is not a little interesting to find a variant of this fable still credited in India.

Mr. Crooke, in his "Popular Religion of Northern India," say: "It is still believed that when a goat kills a snake it eats it, and then ruminates, after which it

* The author of "Pleasures Afoot, Afield, and Afloat" says: "Most of the small deer are preserved by the odor they emit. A bit of fresh deer-skin will keep off snakes and the odor of musk will suffocate them. Very few reptiles will go near a musk deer, and even the most seemingly helpless creatures appear to be furnished with a weapon against its most common antagonist.'"

† British Medical Journal, August 17, 1890.

‡ Mr. Bolton, L.R.C.P., writing in The Lancet, in 1886, stated that the natives in Bechuanaland, Namaqualand, Demaraland, and the Kalahari are in the habit of extracting the poison gland from a snake immediately it is killed, squeezing it into their mouths, and that they thereby appear to acquire absolute immunity from the effects of snake-bite.

‖ Two Happy Years in Ceylon, Vol. I., p. 125.

§ Schliemann's Troy, p. 117.

* This was doubtless a puff-adder, which is so named from its pecularity of emitting puffs of breath; but, although very venemous, we never now hear of its killing by its breath.

† "Lobo's Voyage to Abyssinia." Pinkerton's Voyages, Vol. I.

spits out a manka or bead, which, when applied to a snake-bite, absorbs the poison and swells. If it is then put into milk and squeezed the poison drops out of it like blood, and the patient is cured.* If it is not put into milk it will burst in pieces." The treatment of this stone by milk in order to eliminate the poison is similar to that of the Corfu bezoar, whilst new milk, administered internally in large quantities, is highly esteemed as a remedy for snake-bite by the Dutch at the Cape. This, in conjunction with salt water and the "serpent-stone," is said, by Thunberg, to have effected the cure of a man who had been bitten by a ringhals, rendering him instantly blind, which blindness continued for a fortnight. "An incision was made round the wound with a knife, and the foot washed with salt water; he drank new milk copiously, and that to the quantity of several pailsful† in a night, but cast it all up again. After this the serpent-stone was applied to the wound. By means of this he gradually recovered."

The use of salt as a remedy seems also widespread; it is used empirically in India and America, but a recent instance of its use in South Africa seems to show that it is really, to some extent, a cure when judiciously applied.

The case alluded to was communicated to a South African paper by Mr. Bowker, a name well known at the Cape. He relates that a Kaffir was bitten by a cobra just above the ankle, the fangs drawing blood. "Then," says Mr. Bowker, "there being no time to lose, and no 'Croft's Tincture' at hand, I at once cut a cross over the place where the fangs entered, causing the blood to flow freely by sucking the poison out. I applied fine salt to the wound, kept the leg quiet, and administered small doses of brandy, a dessert spoonful every half hour, until he became dead drunk. This process lasted for about twelve hours. The next day he was quite blind, the second day he could see a little, the third, fourth, and fifth day he still complained of slight giddiness; the sixth day he was quite well and able to do his work."

Mr. Bowker says his father had often used salt successfully as a remedy in similar cases; but it is easy to see that the suction and the brandy were probably the most important factors in the cure. It is not, however, everybody who would have the courage to apply suction in a case of snake-bite. The slightest abrasion of the lips or tongue would probably prove fatal; it is therefore, not surprising that the bezoar which, when properly absorbed and promptly applied, performed the same good office as the human mouth without risk, should be regarded as something magical. The wonder is that it should have dropped out of use instead of having been taken up and improved by modern science. The reason, however, of this neglect is not hard to find; the fabulous origin and magical properties attributed to it, and shared by stones of no therapeutic value, rendered it an object of ridicule, and obscured whatever merit it might possess, so that in a scientific age no physician dared to recommend it, lest he should be deemed a believer in magic.

There can, however, be no doubt whatever of the value of suction in the case of any poisonous bite, and even the savage aborigines of New South Wales have learned to apply it to snake-bite, after which they encourage bleeding by the application of pieces of hot opossum skin frequently changed.

Mr. Gomme, in an article upon "Totemism in Britain" in The Archæological Review, gives an instance in which the therapeutic value of suction has passed into the empiric stage; he says that "Totems assist their clansmen by acting as doctors; one of the snake class of Asia Minor believing that if bitten by an adder they had only to put a snake to the wound and their totem would suck out the poison." Here we seem upon the verge of that curious and widespread worship of the serpent which is a survival from prehistoric times, and may still be traced in both hemispheres in many superstitions and almost identical usages, by which the snake, regarded as the totem, or the abode of a deceased ancestor, may be propitiated. Hence, the snake may not be killed, and should a man be bitten he must not mention the fact. In India they say, "A rope has touched me;"‡ in America the prescribed formula is, "I have been scratched by a briar," and as a natural sequence the remedy is in the form of a charm, sometimes, but not always, combined with herbal medicines and outward applications.

The following is the prescription of a Cherokee medicine man for snake-bite, as given in Mr. Mooney's "Sacred Formulæ of the Cherokees," in the Smithsonian Report of the Bureau of Ethnology, Vol. VII., "Rub tobacco-juice on the bite for some time, or if there be no tobacco, just rub on saliva once. In rubbing it on, one must go around four times. Go around toward the left and blow four times in a circle. This is because on lying down the snake always coils to the right, and this is just the same as uncoiling it." This prescription is accompanied by a song of which Mr. Mooney gives the translation:

"Listen! Ha! It is only a common frog which has passed by and put it into you.
Listen! Ha! It is only an Usu'gi which has passsd by and put it into you."

Here the frog takes the place of the briar, and is spoken of as the aggressor, in order that the rattlesnake may not be offended by being named. "When one dreams that he has been bitten by a snake he must be treated as though actually bitten, or the same effects will follow a year or so latter."

Mrs. Stevenson, who describes graphically the way in which rattlesnakes are handled by the Sia at their annual rain ceremonial, says that those taking part in it, who are always either members of the snake society or novices entering one of the degrees of the society, are purified by taking an emetic for four days before the ceremony. This emetic is made of the stalks and roots of two plants crushed and mixed with water; but she says this emetic is not given, as has been supposed by some, in order to prevent the poisonous effects of snake-bite, but simply by way of purification. "Medicine for snake-bite" she adds, "is employed only after one has been bitten; for this purpose the Sia use the plant Aplopapus spinulosus, in conjunction with ká-wai-aite, a mixture of the pollen of edible and medicinal plants. An ounce of the plant medicine is put into a quart of water and boiled; about a gill or so is drunk warm three times daily during the four days, and the afflicted part is bathed with the tea and wrapped with a cloth wet with it. An hour after each draught of the tea a pinch of the ká-wai-aite is drunk in a gill of water. The patient is secluded four days." The reason for the seclusion is a curious superstition which prevails among the Zunis as well as the Sia, which is that, should the sufferer look upon a nursing mother, death would result.*

When, however, we read of the way in which the rattlesnakes are handled by members of the society at this ceremonial, being first captured and placed in sacred vases, then each taken out separately, handed from one to another, allowed to twine round the neck, replaced in the vases, carried therein by men to a considerable distance, again taken out separately and allowed to escape, we cannot help thinking that these men must have found some means of preventing the reptiles from biting, or of rendering themselves immune; and, indeed, we find among the Ojibwa the rattlesnake itself used, mixed with other things, to concoct a magic medicine. The rattlesnake is partially crushed and hung up, the drippings being collected and dried, and used in a powdered form.† They also use Aristolochia serpentaria, Virginian or black snake-root, chewed and spat upon the wound, as a cure for snake-bite.

Another famous remedy among the American Indians is the rattlesnake-weed, so-called because it is believed that when rattlesnakes fight the one wounded resorts to this plant and is cured.‡ The seed of this weed is furnished with sharp barbs called stickers in California, and we are told that the early settlers made their herdsmen always carry a bottle of extract of this plant to treat therewith any cattle or sheep which might be bitten, and it is affirmed that the remedy was always effectual. Although the American Indians hold the rattlesnake in veneration, regarding it as a beneficent and protective genius, and not suffering it to be killed within the limits of the camp by their own people, they gladly allow the white man to destroy it, but there is always a dread of offending their powerful divinity. Hence the objection to name the offender when a man has been bitten, and the anxiety not to speak of the mysteries of the medicine-dances except when the rattlesnakes are hibernating, so that they cannot hear. When Mr. Stevenson wished to possess himself of one of the ancient vases in which the snakes are placed at the Sia ceremony, he was told, "These cannot be parted with. They are so old that no one can tell when the Sia first had them; they were made by our people of long ago; and the snakes would be very angry if the Sia parted with these vases." Afterward he was waited upon by the members of the council of the snake society, and the honaaite (priest) thus addressed him:

"You have come to us as a friend; we have learned to regard you as a brother, and we wish to do all we can for you; we are sorry we cannot give you one of the vases; we talked about letting you have one, but we concluded it would not do; it would excite the anger of the snakes, and perhaps all of our women and little ones would be bitten and die. You will not be angry, for our hearts are yours."

In the end, however, the vicar of the society conveyed one of the vases to Mr. Stevenson secretly, urging him to pack it up at once, meanwhile depositing a sacred plume in it, sprinkling it with meal, and praying with tears running down his cheeks.‖

Sacred meal, which plays such an important part in all the American ceremonies, being always sprinkled upon people and places to sanctify them, is freely showered upon the rattlesnakes used in the snake dances, and they are said to devour it, licking it in with their forked tongues; corn pollen is used instead of meal by the snake society, as more acceptable to the honaaite. In all these American ceremonies a line of sacred meal, or corn pollen, is drawn round the altar, or in certain directions, forming a sanctuary within which no one is permitted to enter; the spirits worshipped alone are supposed to cross this line and to animate their images or fetishes placed upon or around the altar.

Both in America and in India snakes are connected with the elements, and propitiatory ceremonies are held and offerings made to induce the snake god to send rain. In India there are numerous survivals of the serpent worship which formerly prevailed very extensively, but Mr. Crooke says: "So far as I am aware, the only place in the Himalaya where the living snake is worshipped is at the foot of the Rotung Pass.§ As may be supposed, however, the superstitions connected with a worship once well nigh universal and of which innumerable shrines still remain, are numerous, and among them are many cures for snake-bite. All through upper India, says Mr. Crooke, the stock remedy for snake-bite is the ojha, or sorcerer, a performance known as jhár phúnk, consisting of a series of passes and incantations which is supposed to disperse the venom.

"In Hoshangabad there were once two brothers, Rájwa and Soral; the ghost of the former cures snake-bite and that of the latter cattle murrain. The moment a man is bitten he must tie a string, or a strip of his dress, in five knots and fasten it round his neck, crying, 'Mercy, O god Rájwa!' To call on Ghori Bádshah, the Delhi Emperor who conquered the country, or Rámji Das Bàba, will do as well. At the same time he makes a vow to give so much to the god if he recovers. When he gets home they use various tests to ascertain if the poison is in him still. They take him in and out of the threshold and light a lamp before him, acts which have the effect of developing latent poison. They then give him salt and the leaves of the bitter nim-tree. If he can take them he is safe. If he cannot take them, the whole village goes out and cries to Rájwa Deo until he recovers. No one (Sir C. A. Elliott's informant told him) had ever been known to die of a snake-bite after this treatment, but the god has no power over the dreaded biscobra.*

This biscobra, or poison-headed serpent, is said to be so venomous as to kill with its breath, like the African serpent of Father Lobo, and like the famed poison maiden of Indian story.

In Ahmadnagar, snake-bite is cured by taking the victim to Bhuroba's temple and giving him crushed nim leaves mixed with chilies to eat, while nim branches are waved round his head.

The nim-tree in India seems to take the place of the ash in Europe as a protection from snakes and witches; but the women in the northwestern provinces make a wavy line of flour round their dwellings as a magic circle over which snakes may not pass. This use of flour is an approach to that of the sacred meal of the American Indians, while the American offering of plumes of different birds to their deities is paralleled in India by the smoking of the tail-feather of a peacock in a tobacco-pipe as a charm against snake-bite.

It is not easy to understand why the peacock's feather should be chosen for this charm; had it been an eagle's plume, such as is used in America, the meaning would be clear, as Guruda, the eagle, is the deadly enemy of snakes, and a propitiatory offering of one of his feathers to the snake-god would seem appropriate.

In India, also, it is a crime to kill a snake, entailing leprosy upon the descendants of the man who commits it, which can only be cured by rubbing the leprous spots with earth from a serpent's hole, and making a pilgrimage to some serpent shrine, wriggling round the shrine several times in imitation of the gliding motion of a serpent. Miss Gordon Cumming describes a plant,† the seeds of which are apparently used as a charm. They are known as Nagadarana, or snake's fangs, because they have sharp curved points like teeth, which inflict a very painful scratch. These are offered to snakes with a small bowl of milk to propitiate them.

In what manner the imagination can so act upon the nerve centers as to cure actual disease is an unsolved, if not an insoluble, problem. That it does so act sometimes appears probable from the numerous so-called miracles and faith cures recorded; but that the deadly venom of a cobra could be neutralized by the superstitious rites traceable to the ancient worship of the serpent passes the bounds of credibility. Therefore, in cases of recovery, it may be assumed either that the bite was not that of a deadly snake; that it was inflicted when the poison-bag had been emptied by recent use; or that the man had become immune through some counter poison previously absorbed.

As regards the antidotes at present in use, Dr. Cunningham, of Calcutta, seems to have proved by a variety of experiments that all are practically useless; nevertheless, many of them have certainly been found efficacious in some cases, although not always to be depended upon. There can be no doubt that a ligature, immediate scarification or excision of the bite, suction to encourage bleeding, the copious injection of strong ammonia, and much brandy taken internally will cure the bite of many snakes. "Croft's Tincture" is also relied upon as a specific at the Cape. The materials of which it is composed are not fully known, but doubtless ammonia is one, and its efficacy has often been attested, although not invariably effectual.

Sir William McGregor, in a paper read before the Royal Colonial Institute, speaking of the natives of New Guinea, says:

"Many of them have come to know the beneficial results of speedily applying permanganate of potash to snake-bite, and will hurry to a missionary or government officer to have this tried. Snakes are numerous, and often their bite is deadly, and in some districts deplorably so. Officers, in dealing with recent cases, are instructed to pinch up between the finger and thumb, or with a forceps, a small bit of skin including the puncture, to cut this out sharply, and to rub the crystals of permanganate of potash into the wound, and then to administer some ammonia or brandy;" and he adds: "There has been so far reason to be satisfied with the results."

Of salt as a remedy in South Africa, India, and America we have already spoken. In some parts of India the blood of the lizard is regarded as a remedy, and a similar remedy, that of turtle blood, was formerly esteemed at the Cape. Thunberg gives an instance of its effectual use, but so many other remedies were tried at the same time that it would be hard to say which was the true antidote. A man was bitten on the hand by a venomous serpent, the hand was scarified immediately, and a cupping-glass applied to extract the poison. It was then steeped in a solution of vitriol, which is said to have become quite black, then an onion was applied, and afterward turtle blood, which last got the credit of the cure. It was laid on the wound in a dry state, and was said to liquefy and show signs of effervescence, "because the poison of serpents has a stronger affinity for turtle blood than for human blood, so as to attract the poison to itself."

A somewhat similar remedy appears to be still in vogue in Wales, for a friend informs me that her son having been bitten on the thumb by a viper in a wood in Wales, which almost cost him his life, the peasants all told her she ought to have tried the local remedy, that is, to kill a fowl, cut it open, and insert the wounded part within the hot and bleeding carcass.‡ This somewhat barbarous practice is doubtless a survival from some old-time superstition of the use of blood as an antidote; but the dried turtle blood of Thunberg seems an approach to the serum treatment of Calmette and Frazer. The experiments of the former show that the serum of some animals is naturally antitoxic to a small extent, especially that of the ichneumon, but whether that is the case with the turtle and lizard we do not know.

Dr. Calmette finds that hypochlorite of lime will destroy serpent venom, and recommends its injection in the parts near and into the wound itself, after the serum

* Op. cit. p. 330.

† For pail read pannikin.

‡ "Snakes," says Mr. Crooke, "should of course be addressed euphemistically as 'maternal uncle,' 'tiger,' or 'rope,' and if a snake bites you, you should never mention its name, but say 'a rope has touched me.'" Popular Religion, etc., p. 275.

* Eleventh Annual Report of the Bureau of Ethnology. Smithsonian Report, p. 98.

† Query, Is not this similar to Dr. Frazer's blood-serum?

‡ I have not entered into the disputed assertion that snakes and mongooses or ichneumons when bitten resort to certain herbal remedies, as these herbs have never been identified.

‖ Report of Bureau of Ethnology, Vol. XI., article "The Sia." Stevenson.

§ Popular Religion and Folk-lore of Northern India. W. Cooke, B.A.

* Popular Religion and Folk-lore in Northern India, pp. 273-4. W. Crooke, B.A.

† Miss Gordon Cumming, Two Happy Years in Ceylon, p. 127.

‡ The Dutch at the Cape are fully persuaded that there is nothing so efficacious in drawing poisons of any kind from a wound as the skin and flesh of a newly-slaughtered animal such as a kid or lamb.

has been injected in the abdomen, which again suggests the pre-scientific mode of the application of external remedies to the wound, some of which have certainly been found efficacious, as, for instance, Croft's Tincture in South Africa. It is said that Cetewayo had a specific never known to fail, in the form of a gray powder, but the composition of this, as of Croft's Tincture, is unknown. The chief remedy of the native doctors is said to be the root of the Aster asper, a small plant somewhat like the daisy, with lilac-colored flowers; but this is only one of many reputed herbal remedies.

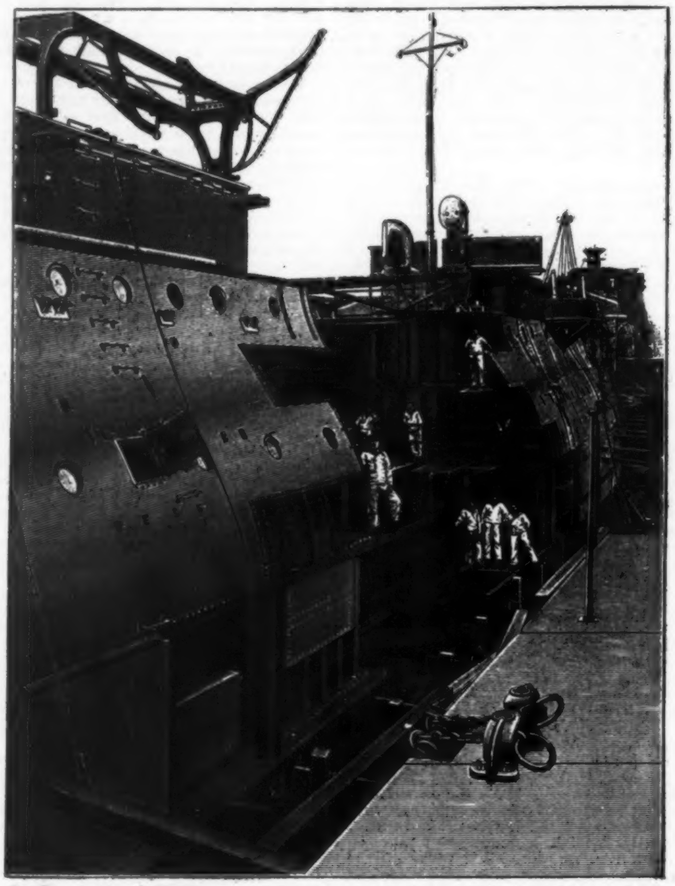
One of the greatest obstacles to the discovery of a truly trustworthy specific for snake-bite is the difference in the strength and quality of the venom of different species of snakes. It is generally agreed that the Indian cobra di capello is the most deadly of all, but there are other Indian snakes, as well as some in South Africa, Egypt, Australia, and the American rattlesnake, which are almost as venomous, although the effect of the poison is not the same and not usually so quickly fatal. The bite of some of the South African snakes produces temporary blindness, while with some of those of Australia it is the kidneys which are chiefly affected. It is, therefore, easy to see the difficulties which attend the discovery of a remedy which will counteract the poisonous bite of all species. This, however, Dr. Calmette claims to have found in his antivenomous serum, which he says is equally efficacious for curing the bite of the cobra di capello and trimerisaurus of Asia, the naja haje and cerastes of Africa, the crotalus of America, the bothrops of the West Indies, the varieties of pseudechis and hiplocephalus of Australia, and the vipers of Europe; but the dose must be varied according to the species of snake, the age of the person bitten, and the time which intervenes between the bite and the application of the remedy. After the injection of the serum, perspiration is to be encouraged, but the administration of ammonia and alcohol, both of which under the old system were looked upon as powerful agents for good, is denounced as positively hurtful, and the cauterization of the wound is regarded as unnecessary.*

Although there can be little doubt of the efficacy of the serum treatment of snake bite, it is hardly likely, at least for many years to come, to make any great reduction in the mortality caused by these reptiles; for the natives, who are the chief victims, will require to be well assured of the efficacy of the remedy before they will submit themselves to the series of inoculations necessary to produce immunity, and the actual wound is generally received in field or jungle remote from medical aid, so that the victim would undoubtedly succumb long before the remedy could be applied. Nevertheless, if only a few can be rescued, the labors of Drs. Calmette and Frazer will not have been in vain; and if, meanwhile, they can so modify the remedy as to make it protective when taken internally, or curative when rubbed into the actual wound, so that it might be applied by the man bitten or his companion in the field, they would indeed deserve to be regarded as benefactors to the human race.—From The Westminster Review, by permission of the Leonard Scott Publication Company.

* See British Medical Journal, July 21, 1895, page 174.

THE LENGTHENING OF H. M. S. "HAGEN."

The German coast-defense steamer "Hagen" has been lengthened 23 feet in order to increase her bunker-capacity, extend her cruising radius, and provide room for a heavier battery. There is nothing unusual in cutting a merchant vessel in two and pulling the sections apart; but the lengthening of a warship is accompanied by greater difficulties. In the one case the weight is either comparatively small or, if the vessel be of large displacement, better distributed over a longer hull. In short, armored ships of the "Siefried" class, the weight is more concentrated and the task proportionately difficult.



LENGTHENING THE GERMAN STEAMER "HAGEN."

First the armor-belt and the turrets were removed in order to lighten the vessel. The rivets were knocked out; and a cradle was built beneath the vessel, similar to that used in launching. Tackle was secured to the port and starboard sides. After the "Hagen" had been cut in two and the cradle liberally smeared with soft soap, two gangs of men heaved away on the tackle, and the after section was slowly pulled away inch by inch from the bow section.—Für Alle Welt.

BERLIN'S ELEVATED RAILWAY.

The street railways which, thirty years ago, were amply sufficient for the needs of Berlin, have long been so lamentably incapable of meeting the requirements of the gradually increasing population, that the construction of a new elevated railway was begun, similar to that used for the past twenty years in New York.

The new road, says the Illustrirte Zeitung, beside re-

THE RECENTLY COMPLETED ELEVATED RAILWAY OF THE CITY OF BERLIN.

lieving the congested condition of the city's traffic, will enable business men to journey from their homes to their offices and from their offices to their homes far more quickly than they could on the slow street cars. The suburbs of Berlin have never been accessible by the old roads. It was, therefore, decided to build a new rapid transit system composed partly of underground, partly of elevated roads, by which all parts of the city, even its very outskirts, could be readily reached. The plan has been at least partially realized with the completion of the elevated railway.

The elevated road connects the eastern and western parts of Berlin, runs through the southern part, and connects these three districts with the center of the city by a branch line terminating at the Potsdamer Platz. As the road is extended, the northern portions of the city will be brought into communication with the other portions. If the far-reaching plan of the authorities be fully carried out, Berlin will have the most elaborate system of city railways in the world.

THE PALACE OF THE ARMIES OF THE LAND AND SEA AT THE PARIS EXPOSITION OF 1900.

ONE of the most important structures of the Exposition of 1900, and one to which the attention of the public will doubtless be in great part directed, is the large palace that is at present constructing upon the banks of the Seine, between the Alma and Jena Bridges. It is 1,180 feet in length, or, in other words, its length is equal to the distance that separates the statue of Jeanne d'Arc from Rue de Rivoli and the Seine.

It has other claims to attract interest than those that proceed from the surface that it covers, and these are the originality of its architecture and the purpose for which the structure is designed.

But let us relate its history, which forms part of that of our third republic, and is even so mixed up therewith that it is difficult to recall all the phases of it. Let us be content to say that originally each of the ministers was to have taken part in the exposition by an independent exhibition, as was done in 1889, when each department had at its disposal a special appropriation, and each was enabled to make its own exhibit. The palace of the Minister of War, upon the Esplanade des Invalides, is still remembered.

The plans had been made for the participation of the ministers in the exposition of 1900, and especially for the edifice of the armies of the land and sea; and it was understood that the State would borrow at its own expense the three million francs necessary for its construction. Everything was ready, and all that was needed was a slight formality—a vote of credit by the chambers. This was the stumbling block. The deputies, who had already voted so many millions for the exposition, refused the money for the representation of the ministers, and so it was necessary to submit, and the fine project that had been presented was killed. We have not forgotten it. Two great porches were to be flanked by two rows of palaces which were to terminate at their extremities in two large vessels, one of which was to recall the past of the French navy, in a superb wooden ship, such as those we see in old engravings, while the other was to speak to us of the present epoch, in an armor-clad provided with all its modern armament. But all of these had to be abandoned. The Commissary-General, however, held out absolutely for the Palace of War. He did not wish to give up the idea that he had conceived of constructing a great palace for the armies; and, while to the advantage of other structures, he relinquished the site originally reserved for the different ministers, he preserved in fact the place on the Seine upon which was to stand the palace under consideration. He had a modification of the initial project so studied as to diminish the expense thereof, and, on another hand, endeavored to collect the money necessary (two million francs) by economy and by draughts upon such funds as were disposable.

In short, the palace, which came near never seeing daylight, received its baptism three months ago, when its construction was awarded to MM. Umbdenstock and Auburtin, the authors of the original project. But the end of the trouble had not come. All the operations that we have recalled had taken up considerable time—so much, in fact, that when it was decided to build the palace it was far too late to construct it of iron.

On account of the dearth of metal that we are now suffering, no builders would agree to furnish the necessary elements in so short a time. It therefore became necessary to discard metal and take up wood, and gangs of carpenters were at once engaged to begin the work. Seven trusses had already been put in place, and everything seemed to be going on well, when one Sunday evening a crane slid and involved the falling of all the work that had so far been done. Despite this accident, there was no loss of courage on the part of those concerned, and the ground was at once cleared and the work begun again. To-day, less than three months from the beginning of the work, and in spite of all difficulties, the whole of the main part of the immense palace is finished.

As the ground upon which the structure was to stand was very bad, it became necessary to sink a large number of piles, and, in some places, even to put three or four one against the other, so as to form sufficiently solid subterranean piers.

The Railway of the West, as well known, runs along the Seine over the entire portion of the wharves set apart for the exposition. The cutting that was made to this effect was afterward covered with a roof of cement, strengthened according to the Hennebique process. The palace is constructed in part upon this covering, and in part upon the banks of the river. No supporting piece, however, was placed directly upon the cement roof; but the walls of the cutting, which are very solid, were put to profit, and upon them were mounted the posts that form the skeleton of the structure.

As may be seen from the section shown in Fig. 3, the Palace of War consists of two buildings placed back to back, one of them constructed over the cutting and the other upon the river bank. The first is divided into a ground floor and a single story above. The second consists of the same elements; but, since a difference of level exists between the foundations, the upper story of this gallery is at the same level as the ground floor of the other part.

The construction did not present much difficulty, except in the flooring of the part built over the railway cutting. The span at this place is 55·75 feet, and the problem was to place across it a straight wooden truss without any intermediate support, since it was impossible to allow it to rest upon the cement covering. The idea occurred to the architects to so calculate this truss that each of its parts should work at a maximum. It therefore constitutes an interesting piece of work of equal resistance. It consists of two chords connected by wooden diagonals at the place where the work is by compression, and iron rods where the stresses are tensions. The number of both corresponds to the value of these different stresses. (Fig. 2.) This truss was constructed by M. Poirier, well known for his work in this line.

At the part of the shore occupied by the palace the Seine makes a bend, and forms a very pronounced convex line, so that it will never be possible to see the entire edifice at a single glance. This, however, is not a misfortune because of its length. In fact, the architecture might appear monotonous were it not spread out uniformly in a straight line for so great a distance.

The principal subject of decoration of the structure is a great porch situated opposite the foot bridge that crosses the Seine. The architects have endeavored to unite these two elements in such a way as to form but one and the same motive, and so that they may appear to have been studied one for the other.

The porch is a large free archway, that is to say, although it forms an integral part of the palace from the view-point of the external architecture, it serves as a whole to separate the palace into two distinct parts, the entrance to which is accessible to those who are walking on the wharves and who do not wish to visit the galleries. As for the foot bridge, that seems to enter the archway, and is like the floor of a gigantic drawbridge lowered in front of the gate of a fortress.

It was a happy idea on the part of the architects not to establish a stairway to connect the banks with the foot bridge. This would have given the work a heavy appearance and have deprived the bridge of the character that makes it seem as if it belonged to the palace. It was, nevertheless, necessary to establish a com-

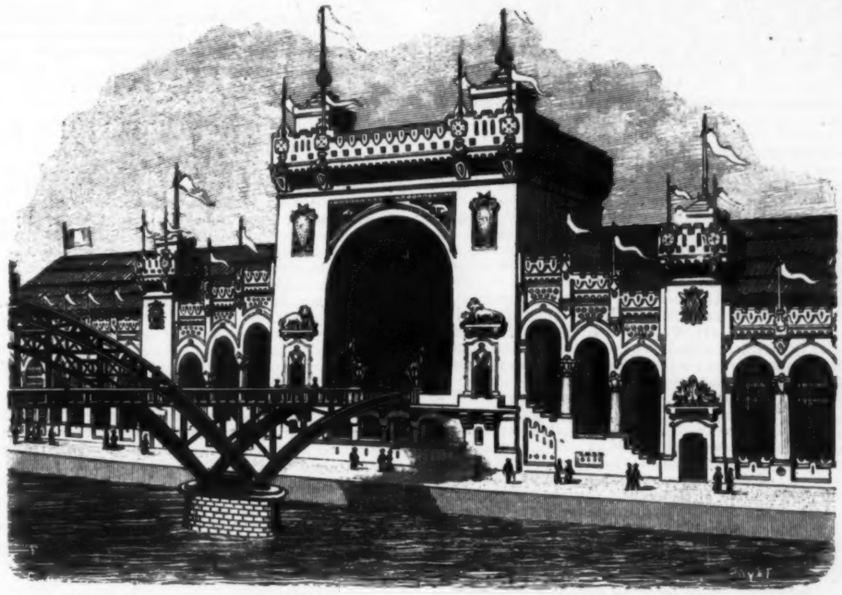


FIG. 1.—FAÇADE OF THE PALACE OF THE ARMIES OF THE LAND AND SEA.

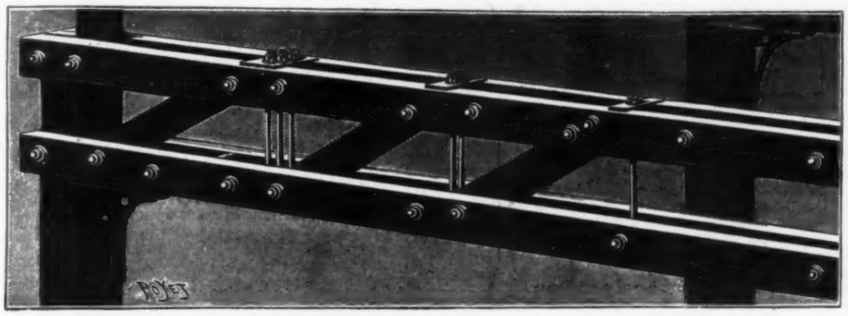


FIG. 2.—ONE OF THE TRUSSES OF THE MAIN FLOOR.

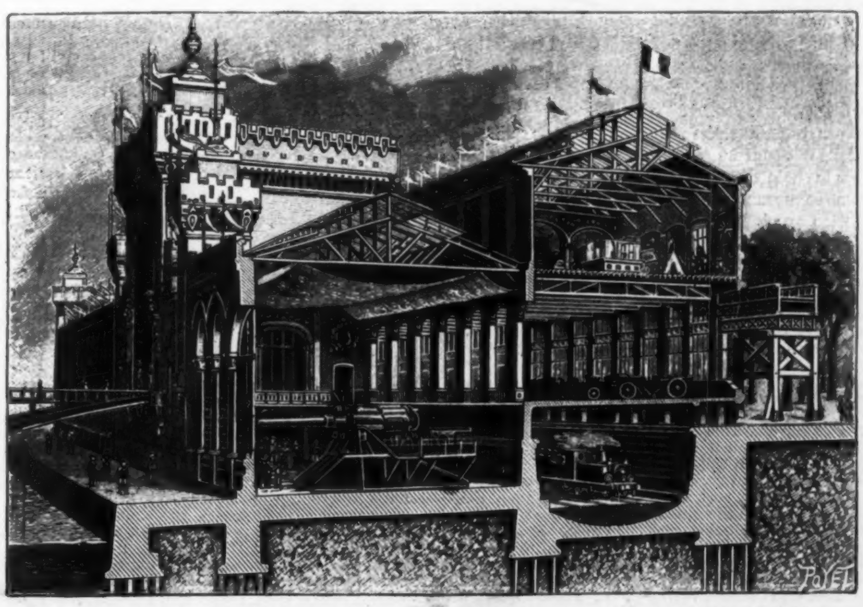


FIG. 3.—TRANSVERSE SECTION OF THE PALACE OF THE ARMIES OF THE LAND AND SEA.

munication between the banks and the bridge, in order that visitors might be able to cross the river: and this is why stairways have been constructed inside of the edifice, in a sort of open gallery. These stairways begin upon the bank and under the porch, which is on a level with the bridge (Fig. 1).

All the decorative motives of the palace recall the object for which it is designated. Thus, the porch is flanked by two large towers, and the wall that separates them is embattled like an ancient fort. Martial allegories and the escutcheons of various regiments have been established on all sides; large statues representing warriors armed with halberds stand in the foreground, and at the back of the porch are to be seen two large equestrian statues of Bayard and Duguesclin.

The arched part of the main porch is glazed with yellow glass so as to give a golden color recalling that of the setting sun. This will increase that impression of mystery and grandeur that the structure ought to produce.

The visitors who are at present promenading upon the wharf, back of the Palace of the Armies of the Land and Sea, are astonished when they observe the comparative thinness of the cement covering (which does not exceed a few fractions of an inch in some places), and express their doubts as to the resistance of such a support, especially when they reflect that heavy pieces of artillery will be exhibited in the halls. Up to the present, people have not become accustomed to cement strengthened with metal, and the eye alone cannot give an impression sufficient for calculating its resistance. This requires reasoning and tests. The first is given by calculation, which entirely satisfies engineers, and the second, the tests, are still more reassuring, since they have been made at 1,000 kilogrammes to the square meter without the production of any great amount of distortion. It may even be said that a test has been made with a much greater weight, since at the time of the fall of the wooden trusses already mentioned, the girders of strengthened concrete were submitted to a formidable shock, and yet did not give way. Such a test is one of the best guarantees of the system.

The perspective that will be unfolded before the eyes of the spectators situated in the palace will be wonderful. Directly opposite will be seen Robida's Old Paris as a whole; to the left will be observed the Trocadero, with its exotic palaces and its tall spires recalling all countries; and in the foreground, upon the Seine, will be seen a port in miniature, with its moles and lighthouse, and which will afford shelter to yachts and other pleasure craft.

The Palace of War will be one of the finest structures of the Exposition, and does great honor to its young architects, MM. Umbdenstock and Auburtin, whose first work it is.

For the foregoing particulars and the illustrations, we are indebted to La Nature.

COMBUSTION IN LIQUID AIR.

WHEN air is liquefied, nitrogen and oxygen condense simultaneously, so that the liquid has the composition of the gas mixture in the air. As soon, however, as evaporation recommences, the composition begins to change. At first the escaping gas is essentially nitrogen. After a while the vapors again contain the two gases in the proportions in which they are found in the atmosphere. That point occurs when about 70 per cent. of the liquid has evaporated, and 81 per cent. of the original nitrogen, and 35 per cent. of the oxygen have escaped; the remaining liquid contains the two bodies in equal proportions; afterwards oxygen begins to predominate in the vapors. These numbers concern evaporation at atmospheric pressure. In vacuo, the evaporation of the two gases proceeds more rapidly; at increased pressure, more slowly. The changes may be observed with the help of a glowing chip of wood. At first the wood will be extinguished when held over the liquid, then it will brighten up, and when dipped into the liquid burn intensely. Powdered carbon, soaked with liquid air, puffs away like gunpowder on ignition, and explodes when a detonator cap is employed. This seems very strange when we think of the exceedingly low temperature of the liquid,—180° Cent.; and in a paper brought before the Bavarian Academy of Science, Carl Linde expresses the opinion that we may have to modify our views on the nature of explosions. Petroleum, absorbed by kieselguhr or powdered cork coal, can be saturated with liquid oxygen. Such a mixture explodes even when not confined. Cartridges filled with it cause others, placed at a distance of 25 centimeters (10 inches) from them to explode, whilst with the highest explosive so far known, blasting gelatine, cartridges 15 centimeters away from the detonating cartridge remain inactive. Linde has tested this preparation at Schlebusch. Within a steel bomb of 20 liters capacity blasting agents are exploded by means of fulminate of mercury. The gas pressure is registered by a piston on a drum which has a circumferential velocity of 330 centimeters (10 feet) per second. The petroleum-liquid air preparation gives a curve which demonstrates that the maximum pressure surpasses that obtained with blasting gelatine, and is reached in a shorter period of time. The preparation was simply wrapped in paper. It is singular that such a mixture should burn more rapidly, in spite of its low temperature, than any solid or liquid compound we know at ordinary temperatures.—Engineering.

A convenient forceps for microscopical use may be made from the wooden toothpicks found at every lunch-counter, or purchasable for a few cents per thousand. For this purpose select three smooth picks. Cut off about one inch from the end of one of the picks, and throw the balance away. Dip the ends of the other picks in liquid glue of any sort, to the depth of an inch, place the short piece upon the glued portion of one pick, making the thin ends coincide, and then place the glued end of the other picks upon the short piece, and around the whole wrap a thread or bit of thin brass wire (such as is used by ladies in needlework), carrying the wrapping up to the inner end of the dividing piece. These forceps are useful in many ways, but especially so in lifting cover-glasses from acid-bleaching solutions, etc. A pair can be made in less than one minute.—National Druggist.

TRADE NOTES AND RECEIPTS.

Black Putty.—A black putty, which is said to be equally well adapted for metal and wood, is produced, according to the Praktischer Wegweiser, by mixing whiting and antimony sulphide, the latter finely powdered, with soluble glass. This putty, it is claimed, can be polished, after hardening, by means of a burnishing agate.

To Prevent the Trickling of Burning Candles.—For the purpose of obviating this evil, it is recommended to dip the candles into the following mixture:

Magnesium sulphate	15	parts.
Dextrin	15	"
Water	100	"

The solution dries quickly and does not affect the burning of the candle.—Pharmaceutiscke Centralhalle.

New Antiseptic Substances.—A German factory is producing new antiseptic substances by the action of aromatic aldehydes upon proteine bodies. Thus, 1 kilogramme of caseine is, for instance, moistened with double the weight of alcohol, and, after adding 150 grammes of salicylaldehyde, heated 4 to 5 hours to 120° C. in the autoclave. The obtained brownish reaction product is washed with alcohol and dried.

By the action of 120 grammes of benzaldehyde on 1 kilogramme of somatose and heating in the autoclave to 110° C., a brown powder is also obtained. Both products are insoluble in organic solvents, but readily soluble in water. The benzaldehyde is similar in taste and smell somewhat to bitter almond oil.

Very similar is the behavior of the condensation products of other proteine bodies, such as egg-albumen, gelatine, glutin, peptone, etc., with the above named, as well as other aromatic aldehydes.—Zeitschrift für analytische Chemie.

Steel-improving Powder.—Léon Budzinski and Basile Schouvaloff, of Paris have prepared and patented a new powder which brought in contact with steel, is said to improve its qualities in many respects. It consists of the following mixture in the approximate proportions as stated:

Buckwheat meal	450	parts.
Corn flour	220	"
Charcoal	300	"
Red pepper	15	"
Asafœtida	15	"

For use, it is only necessary to place the steel heated to redness, into the powder, leaving it to cool therein, until it acquires the well-known blue color. The action of the powder upon the steel extends over a layer of about 4 centimeters and if a still deeper action is desired, one only needs to apply a second treatment.

The steel thus heated exhibits considerable softness, so that it can be very easily worked. The subsequent hardening requires no new arrangement, being affected in the ordinary manner, even with less heating. The metal is rendered exceedingly resistive thereby, much more so, than if the original steel had not been subjected to the action of the powder. The fracture of the steel thus treated shows a finer grain than before the application of the powder. In the case of burnt steel a still more surprising result is obtained—it is completely regenerated and the metal attains a greater resisting power than before its deterioration.

Hence the treatment of the steel is said to offer the following advantages:

It renders the steel soft, so that it is very easily worked, but still re-obtains a greater strength, by ordinary hardening methods, than without the use of this mixture.

It renders the stratum very homogeneous, so that the fractures shows a finer grain.

It regenerates overheated steel so that it becomes even more resistant than before it was burned.—Neueste Erfindungen und Erfahungen.

Viennese Metal Cement.—Copper amalgam or so-called Viennese metal cement is enjoying a considerable employment in various industrial branches owing to its special properties. This amalgam crystallizes with the greatest readiness and acquires such hardness on solidifying that it can be polished like gold. The amalgam may also be worked under the hammer or between rollers, it can also be stamped and retains its metallic luster for a long time in the air. In air containing hydrogen sulphide however it quickly tarnishes and turns black.

A very special property of copper amalgam consists in that it becomes very soft when laid in water, and attains such pliancy that it can be employed for modeling the most delicate objects. After a few hours, the amalgam congeals again into a very fine grained, rather malleable mass.

An important application of copper amalgam is that for cementing metals. All that is necessary for this purpose is to heat the metals, which must be bright, to 80-90° C., to apply the amalgam and to press the metal pieces together. They will cohere so firmly as though soldered together.

Copper amalgam may be prepared in the following manner:

Place strips of zinc in a solution of blue vitriol and agitate the solution thoroughly. The copper thus obtained in the form of a very fine powder is washed and, while still moist, treated in a mortar with a solution of mercurous nitrate. The copper powder thereby amalgamates more readily with the quicksilver. Next, hot water is poured over the copper, the mortar is kept hot and the mercury added. Knead with the pestle of the mortar until the copper pulverulent in the beginning, has united with the mercury into a very plastic mass. The longer the kneading is continued the more uniform will be the mass. As soon as the amalgam has acquired the suitable character—for its production 3 parts of copper and 7 parts of mercury are used—the water is poured off and the still soft amalgam is given the shape in which it is to be kept.

For cementing purposes, the amalgam is rolled out into small cylinders, whose diameter, is about 4 to 5 millimeters, with a length of a few centimeters. In order to produce with this amalgam impressions of castings, which are made after wood cuts, the amalgam is rolled out hot into a thin plate and pressed firmly onto the likewise heated plaster cast. After the amalgam has hardened the thin plate of it may be reinforced by pouring on molten type metal.—Der Metallarbeiter.

SELECTED FORMULÆ.

Cement for Rubber and Leather.—To unite rubber with leather, roughen both surfaces with a sharp glass edge; apply on both a diluted solution of gutta percha in carbon bisulphide, and let the solution soak into the material. Then press upon each surface a skin of gutta percha, 0·25 millimeter in thickness, between rolls. The two surfaces are now united in a press, which should be warm but not hot. This method should answer in all cases where it is applicable. Another prescription covers cases in which a press cannot be used. Cut 30 parts of rubber into small pieces, and dissolve it in 140 parts of carbon bisulphide, the vessel being placed on a water bath of 30° C. (86° F.). Further, melt 10 parts of rubber with 15 of colophony, and add 35 parts of oil of turpentine. When the rubber has been completely dissolved, the two liquids may be mixed. The resulting cement must be kept well corked.

Treating Old Ceilings.—In dealing with old ceilings, the distemper must be washed off right down to the plaster face, all cracks raked out and stopped with putty (plaster of paris and distemper mixed), and the whole rubbed smooth with pumice-stone and water; stained parts should be painted with oil color, and the whole clear-coled and distempered as before described. If old ceilings are in bad condition, it is desirable that they should be lined with paper, which should have a coat of weak size before being distempered.

New Formula for Kalsomine.—Whiting, 10 pound; sal soda, ½ pound; white glue, ¾ pound; linseed oil, one quart, dissolve the sal soda in hot water, then stir in the oil. Now add more warm water and stir in the whiting. Melt the glue in the usual manner and stir that in, when the kalsomine is finished. A lime kalsomine or wash, made as follows, is good for cheap work: Take six quarts thick lime whitewash made of the best lime slacked in hot water. Mix turps and linseed oil of each half a pint, and stir it in while the wash is hot, then add a half pound of powdered alum. Have the mixture thick enough to cover like kalsomine and put it on with a kalsomine brush. The edges dry slowly, and no matter how much suction there may be in the wall the wash will spread smooth and easy.—Western Painter.

Cure for Influenza.—President Loubet, M. Waldeck Rousseau, and other distinguished Frenchmen have been quickly relieved of influenza by a new cure, the discovery of Dr. Borne, Deputy for Doubs. As soon as one feels the symptoms of influenza one should have the two following prescriptions made up firstly:

Chloroform	2	oz.
Water	2	"
Magnesia	2	dr.
Salol	15	gr.
Betol	15	"
Antifebrin	15	"
Sirup of orange flowers	1	oz.

This must be well shaken and a teaspoonful taken every 15 or 20 minutes during the first day. On the following days one should take two cachets on rising in the morning and two on going to bed at night, composed as follows:

Magnesia	2½	dr.
Betol	75	gr.
Salol	45	"
Terpine	45	"

For 20 cachets.

Dr. Borne, who made no difficulty about rendering his efficacious prescriptions public, said his principle was that all the digestive, respiratory tubes, etc., should be disinfected. Of course, the doses were modified according to the age, condition, and so forth of the patient.—British and Colonial Druggist.

Preserving Cut Flowers.—(J. S. D.) The English method of preserving flowers so as to retain there form and color is to imbed the plants in a mixture of equal quantities of plaster of paris and lime, and gradually heat them to a temperature of 100°. After this the flower looks dusty, but if it is laid aside for an hour so as to absorb sufficient moisture to destroy its brittleness, it can be dusted without injury. To remove the hoary appearance which is often left, even after dusting, a varnish composed of 5 ounces of dammar and 16 ounces of oil of turpentine should be used and a second coat given if necessary. When the gum has been dissolved in the turpentine, 16 ounces of benzolin should be added, and the whole should be strained through fine muslin. Another preserving varnish is composed of 500 parts ether, 20 parts transparent copal, and 20 parts sand. The flowers should be immersed in the varnish for two minutes, then allowed to dry for ten minutes, and this treatment should be repeated five or six times. Still another method, which is used in the Paris Museum of Natural History, is to place the flowers in a solution of 30 grains of salicylic acid in 1 quart of water.

The following method published some years ago in Zeitschrift d. oestr. Apoth. Ver., Prof. Pfitzer declares will preserve flowers so that they retain their natural colors and shape: Moisten 1,000 parts of fine white sand that has been previously well washed and thoroughly dried and sifted, with a solution consisting of 3 parts of stearin, 3 parts of paraffin, 3 parts of salicylic acid and 100 parts of alcohol. Work the sand up thoroughly so that every grain of it is impregnated with the mixture, and then spread it out and let it become perfectly dry. To use, place the flowers in a suitable box, the bottom of which has been covered wtth a portion of the prepared sand, and then dust the latter over them until all the interstices have been completely filled with it. Close the box lightly and put it in a place where it can be maintained at a temperature of from 30° to 40° C. for two or three days. At the expiration of this time remove the box and let the sand escape. The flowers can then be put into suitable receptacles or glass cases without fear of deterioration. Flowers that have become wilted or withered before preparation should have their color freshened up by dipping into a suitable anilin solution.

Gold Varnish for Brass.—

Seedlac	90	parts.
Copal	30	"
Dragon's blood	1	"
Alcohol	600	"

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Notes on Dawson and Cape Nome. — Business in Dawson this season has been very quiet, chiefly because the population is nearly 6,000 less than last year says Vice-Consul Ronald Morrison of Dawson City. Prices, however, remain firm and an inquiry at several of the leading stores shows the following percentages of profit still obtaining: On drugs and medicines, 300 per cent.; books and stationary, 500 per cent.; boots and shoes, 150 per cent.; clothing, 50 per cent.; groceries, 200 per cent.; hardware, 400 per cent. Champagne, any grand, sells at $240 per case of 1 dozen quarts; beer, in barrels containing 8 dozen bottles, $100 per barrel; whisky, $35 to $45 per case of one dozen bottles, or $40 to $60 per gallon.

In addition to the duty on liquors, there is a further tax of $2 per imperial gallon, called the "federal tax." Saloon licenses are worth $2,500 per annum. A singular feature in connection with these is a charge of $50 for an application for a license. If the application is denied, the $50 is not returned to the applicant. The revenue estimated by the finance committee of the Yukon council from liquor permits for the fiscal year ending June 30, 1900, is $100,000; for licenses, $90,000.

The flooding of many of the mines on the various creeks, as the result of the continuation of the mild weather early in the season, may have an effect upon the output for the year. It is still rather early to venture on a forecast; but, taking into consideration the improved methods now employed, a conservative estimate places the figures at from $25,000,000 to $30,000,000.

Nineteen expeditions have left Dawson for the Nome district since December 4, 1899, and as the days lengthen and the weather moderates many more will start. It is reported here that seven hundred are now on the way from Skagway. Late news from Nome by mail from St. Michael confirms the reports of the richness of the district, and also announces new finds in the interior; but lack of fuel prohibits these being worked in the winter. Typhoid fever has made its appearance, and the mortality from this disease is increasing.

Germany's Machine Exports.—The following dated Chemnitz, January 13, 1900, has been received from Vice-Consul Monaghan:

The following figures are very interesting and go to show the progress Germany is making in the markets of the world, especially in machinery. In 1899 she exported 88,285 tons, worth $16,065,000. In 1898 the export went up to 191,020 tons, worth $35,224,000. This is an increase of 120 per cent. This increase would have been much greater, it is claimed, had not the home demand assumed such gigantic proportions as to prevent German manufacturers giving close attention to the outside world. The country that played the most important part in this increase in Russia. Switzerland came second; then England, Denmark, Roumania, Italy, Holland, Sweden, Norway, and last of all the United States. The importation of machinery into Germany increased from 57,300 tons in 1890 (worth $10,473,000) to 83,760 tons in 1898 (worth $13,328,000). This increase is due mostly to the importation of American machines.

In regard to the export of machine to Russia, Vice-Consul-General Hanauer, under date of Frankfort, January 15, 1900, gives details as follows:

In the eleven months ending November 30, 1899, German locomotives and locomobiles shipped to Russia amounted to 11,000,000 pounds, against 5,900,000 pounds for the same period of the previous year. The shipments in cast iron machines gained 28,000,000 pounds, and those of wrought iron 2,000,000 pounds during eleven months, as compared with the same period of 1898. The gain in money value of these three lines is estimated to be about $2,600,000. Sewing machines also increased.

German Opinion of American Locomotives.—A Chemnitz newspaper publishes the following: "The public was recently told, regarding the granting of a contract for twenty locomotives to an American firm by the Saxon government, that the American bid was not the lowest, but that it came near the lowest. Even this is not confirmed, at least so we learn from well-informed parties. The Baldwin Locomotive Works, in order to get a profitable result as soon as the decision should be known, acted in the real American manner by informing the government, after the publication of bids, that its price did not include the German duties.* This would easily add 4,000 marks (nearly $1,000) to each locomotive. This fact puts the price of quite a number of German firms lower than the American, and their beautiful advertisement amounts to nothing. We are convinced that under these circumstances it would never occur to the directors of our State railroads to send the money of Saxon taxpayers to America, in order to get goods acknowledged to be inferior—locomotives built by the dozen. . . . This business trick is a good brother to the one played by some American tool-making mills that have the habit of delivering 22,000-kilogram machines instead of those of 30,000 kilograms contracted for, taking care to collect pay before delivery. If one takes the trade practices of the trans-Atlantic industries into consideration, one must certainly admit that the German industries, thank God, have remained behind."

The fault found with our engines — that they are made by the dozen — is one of their great virtues. Only a day or two ago, an important dealer pointed out as a weakness of the German locomotives the fact that new parts had to be fitted. The animus of this article is obviously hostile. The big machine shops of this city are full of English and American machines, or copies of them.—J. F. MONAGHAN, Vice and Acting Consul, at Chemnitz.

Adulteration of Food Articles in Germany.—The following, dated Frankfort, January 11, 1900, has been received from Consul-General Guenther:

The Deutsche Zuckerindustrie, a journal devoted to the sugar industry, reports that a German manufacturer of fruit sirups was recently fined 30 marks ($7.14) for adding glucose to fruit sirups. This addition was considered a violation of the law of May 14, 1874, relating to articles of food. The court held that the public, in buying fruit sirups, had a right to expect perfectly pure fruit juice and refined sugar.

American Coal for Germany.—In a recent report from this consulate it was stated that there now prevails throughout Europe, and notably in Germany, a serious deficit in the supply of both anthracite and bituminous coal; that the ordinary large import from Great Britain into Germany is for the moment practically suspended, by season of short supply and high prices; and that the present is, therefore, a favorable opportunity for the introduction of American coals into the German market. Each succeeding day during the past fortnight has increased the general deficit of fuel, and the situation has become critical and ominous for the manufacturers and export trade of Germany. Numerous important glass, porcelain, and machine factories in Silesia and Saxony have been obliged to shut down for want of fuel; there are a dozen electric lighting and power plants in this country which have less than a fortnight's coal provision on hand and no source from which to obtain further supplies. Wood, brown coal, and other unusual forms of fuel are being used wherever possible as substitutes for coal, and the administration of Prussian State railways is said to have closed its contract for an immense coal supply at an advance of 42 per cent. over the high price hitherto paid.

From the best obtainable information, it is estimated that Great Britain, which exported to Germany about 5,000,000 tons of anthracite and bituminous coals during the year 1899, will not be able to spare for this country more than 2,000,000 tons during the present year; so that there will be a deficit of about 3,000,000 tons in the imports from that country alone, which will have to be filled from some other source. Failing to obtain such a supply, the production of pig iron, and consequently steel and all forms of manufactured iron will be seriously reduced in Germany, and this unfortunate crisis comes at a time when most of the large steel works, foundries, shipyards, and machine shops of this country are filled with orders which will absorb their entire product for several months to come.

In Russia, the situation is equally urgent and critical. The enormous and rapid development of railways and certain manufactures in that country during the past three years has completely outrun the limited domestic coal supply so that naphtha fuel, which has been hitherto largely used, has advanced in price from 4 to 19 copecks (2·06 to 9·8 cents), and the Russian government has sought to ease the pressure by suspending for an indefinite period the usual prohibitory import duty of $2.80 per ton on coal. Even the Russian government railways are said to be short of coal, and an agent has been this week in Berlin vainly seeking to place an order for several hundred thousand tons for that purpose.

The principal wholesale agency here for Silesian soft coal—of the qualities used for steam and general manufacturing purposes—is now selling its scanty stock at 21 marks ($5) per ton, delivered at Berlin, and there is a general panic among coal dealers, who are unable to provide coal for their customers at any price and can see no encouraging prospect of obtaining their next season's supply. Offers are made of 17 to 18 marks ($4.04 to $4.28) for bituminous lump coal in lots of 10,000 to 20,000 tons, free on board at Hamburg, and this consulate is beset with inquiries as to the prospect for a new supply from the United States.

If, therefore, there is now available any important surplus coal in the United States, this would appear to be an ideal opportunity for American exporters to open direct relations with leading importers in this country and by establishing their qualities of both anthracite and bituminous coals among consumers in Germany and other European countries, grasp the beginnings of a trade which, if properly managed, should grow into vast and permanent importance. If such available surplus is not on hand, it is because the export coal trade of the United States—like certain other branches of our foreign commerce—has yet to be properly organized and developed.

No one familiar with the facts can doubt that American coal of all kinds—anthracite, cannel, bituminous block and lump, and the high-grade gas and coking coals of Pennsylvania and West Virginia—are among the best in the world. But for all this, and notwithstanding coal at the pit's mouth in West Virginia has sold during the past year at 80 cents per ton; notwithstanding the cheap freights and large facilities for transporting minerals from the principal mining districts to the seaboard—the United States, which leads the world in this product and mined last year 218,335,000 tons of coal, exported only a bagatelle of 5,051,933 tons,* of which 3,631,761 tons were merely carried over the frontier into British North America, and the rest went nearly all to Mexico and the West Indies, countries which lie at our very doors.

On the other hand, Great Britain, with her deep and difficult mines and waning deposits, the extent of which is limited and definitely known, exported 36,546,152 tons of coal in 1898, valued at about $90,000,000, beside the vast amount supplied to steamers engaged in the foreign trade. The coaling stations in South America, Africa, the Mediterranean, and, to a great extent, in Asia, are supplied with British coal; and at each one of these points will now be felt the pressure resulting from high prices in the United Kingdom and the temporary absorption of a large part of British tonnage in transportation growing out of the war in South Africa.

It is not creditable to American enterprise that a country with such exhaustless deposits of superior coal as the United States, where it can be so easily mined and so cheaply transported to tide water, should export less than 3 per cent. of its annual product, and most of this to a neighbor across its longest land frontier.

The subject of coal export is, of course, intricately involved with that of a merchant marine. Great Britain has the colliers, both steam and sail, and they have hitherto carried her coal trade around the world. American coal operators, with all their advantages in respect to supply, cheapness of production, and local transport, have meanwhile been content to meet simply the needs of our own country. Some time in the process of development this anomalous situation must end in the case of coal, as it has already ended in respect to iron and steel, machinery, cotton goods, shoes, and other kinds of manufactured merchandise; and the present coal famine in Germany and other European countries should give a potent impetus to a new movement which will in time place the United States among the foremost coal exporting nations of the world.

Parquet Floors in the Netherlands.—In reply to a correspondent, Consul Listoe, of Rotterdam, on January 20, 1900, says:

Parquet floors are in use in the Netherlands only to a very limited extent. The principal, if not the only, dealer in this article in Botterdam informs me that he does not sell on an average one floor a month. Such as are used are always of oak, as maple and beech have been found too soft for this purpose in this climate. The size of the pieces for a floor is 15 by 15 inches and 1 inch in thickness, and the price is from 6 to 9 florins per square meter ($2 to $3 per square yard). Occasionally, a parquet floor only three-fourths of an inch in thickness is imported from England and sells for 4 florins per square meter ($1.30 per square yard). So far as I have been able to ascertain, there is only one manufacturer of parquet floors in this consular district—Van Nalsen Brothers, at The Hague. The present source of supply is Cologne and Crefeld, Germany, whence parquet floors are forwarded to this place in about four days after being ordered.

It will be seen from the foregoing that at present there is no great market for parquet floors in Holland, and a successful export business from the United States can hardly be expected until the Dutch taste in this line has been cultivated to a greater extent than at present.

Congress of Navigation at Paris.—The Department has received a copy of the programme of the eighth international congress of navigation, to be held at Paris from July 28 to August 3, 1900. Members will consist of delegates of the French government and of foreign governments; delegates accredited by chambers of commerce, cities, navigation and towing societies, railroad and transportation companies, technical, scientific, and industrial societies and syndicates, and individuals who have signified to the organizing committee, before the opening of the session, their intention of becoming members. The committee desires to be informed as soon as possible of the approximate number of members. The programme comprises the following:

FIRST SECTION.—INLAND NAVIGATION, WORKS.

First question.—Effect of regulating works upon the regimen of rivers. (To show especially the effect of these works upon inundations.)

Second question.—Progress made in mechanical applications to the feeding of canals.

SECOND SECTION.—INLAND NAVIGATION, OPERATION.

Third question.—Utilization of natural navigable waterways of restricted depth above their maritime section. (Methods of operation and kinds of boats of light draught of water, such as are specially susceptible of application to the colonies.)

Fourth question.—Progress made in mechanical applications in the operation of navigable waterways. Privileged traction companies.

Fifth question.—Institutions to pension and instruct the personnel of the boat crews.

THIRD SECTION.—MARITIME NAVIGATION, WORKS.

Sixth question.—The latest improvements in lighting and buoying coasts and harbor entrances.

Seventh question.—The most recently constructed works in the principal coastwise or maritime ports.

FOURTH SECTION.—MARITIME NAVIGATION, OPERATION.

Eighth question.—Facilities to be given to ports to meet the demands of ocean going ships. (Dimensions to be given to the principal works and the general navigable conditions required.)

Ninth question.—Progress in mechanical applications to the plants and other facilities of the ports.

Copper and Silver in Ecuador.—Consul-General De Leon writes from Guayaquil, January 13, 1900:

Within the last few days, a gentleman has brought to my office specimens of copper and silver ores, which analyses show to be very rich. The mines are about 35 miles from the coast, in the province of Ahuay, at an altitude of about 5,000 feet. The investigations so far made are most promising, and it is believed the deposits are of great extent. Parties in the United States who are interested can obtain full particulars by applying to this office. The property is controlled by a European metallurgist of experience and ability, entirely reliable, and a resident of this republic for a number of yeas. The copper mines of Peru are, I am told, paying very handsomely.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted

* Note by Consul.—The attitude of the Baldwin people is natural, since the roads in this Empire are, for the most part, owned by the governments; it also finds a parallel in a case here in which the parties selling to our government not only left the tariff entirely out of the question, but refused to pay the consular fees, referring the consul to his government to get them.

Note by Bureau of Foreign Commerce.—It appears also that the omission of the duties in the tender was discovered, and the correction made by the Baldwin Works, before any action was taken upon the bids

* Note by Bureau of Foreign Commerce.—Mr. Mason's figures are for fiscal year ended June 30, 1899. it is noticeable that exports of coal from the United States increased $3,000,000 in value, as compared with the previous calendar year.

CYCLE NOVELTIES IN ENGLAND.

FOR the first time, says The Engineer, the annual exhibitions of cycles, machine tools, and other motor carriages, known as the Stanley and the National Shows, were held concurrently, the former at the Agricultural Hall, Islington, and the latter at the Crystal Palace, Sydenham. The Agricultural Hall probably never contained a better collection of machines, although the numbers may have been greater. The falling off in this direction was due no doubt to the depression through which the cycle trade has for some time been passing. Most of the larger firms were still represented, but the smaller makers—or, perhaps, they should be called assemblers of parts—were noticeable

FIG. 1.

largely by their absence. Nevertheless, there were nearly 300 exhibitors and about 1,500 machines. The junior exhibition at the Crystal Palace also suffered as regards the number of exhibits, but the more extended display of motor carriages compensated to a large extent for the reduced number of cycles. The feature of the show was, of course, the "free wheel," which, whatever its advantages or disadvantages, has the appearance of becoming at one bound almost as universal as the pneumatic tire, and will give a much-needed fillip to the cycle manufacturing industry. In the general design of the frames there is not much to call for comment. The modified diamond frame still remains supreme, but there were seen a few alternatives. Of pneumatic tires the number still increases, the object of inventors being apparently to devise some means of securing the covers which shall not be held as an infringement of the Dunlop patents—an ex-

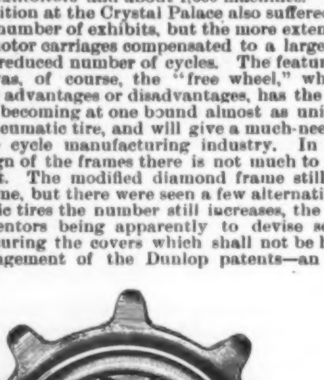


FIG. 2.

tremely difficult and delicate undertaking. In constructive materials steel still holds the field, the high expectations of aluminium and its alloys formed a few years ago have so far not been entirely realized. It is satisfactory to note that the excessive competition among cycle makers has at last resulted in the production of moderate-priced machines, as an instance of which one well-known English firm is now showing a bicycle which the public can purchase for eight guineas.

Turning to the construction of the frames, perhaps the most remarkable departure from prevailing custom is that of the "Little John" Cycle Company, which is particularly applicable to racing machines. Instead of the usual steering head and overhanging handle-bars, this company make a triangular front, the apex of the triangle being at the front wheel center, and the forks forming two sides of the triangle extend upward, to form the handles for steering. It is

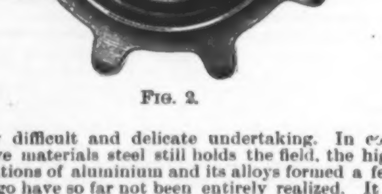


FIG. 3.

claimed that this design gives a somewhat lighter frame, better steering, and there is less "whip" than with the ordinary indirect steering. The main frame of the machine is of true diamond shape. The Palmers Shipbuilding and Iron Company exhibited a new form of frame, called the Harnett-Palmer, the object of which is to provide a vibration insulator. It is not a spring frame in the usual acceptance of the word, but has an additional limb over the two wheels, in which are provided springs, by compressing which the wheels can rise—when passing over an obstacle such as a brick—without communicating the motion to the frame and rider. The alteration does not improve the appearance of the bicycle, and it is questionable whether such an innovation was a necessity. Vibration is chiefly felt in the arms and hands, and to avoid this the Metallic Anti-vibration Handle-bar Syndicate have replaced the horizontal plain tube by a coiled tube of smaller diameter. Another departure in frames has been devised by the Excelsior Pneumatic Ball Tire Company, of Hull. In this case two lever arms extend along the front and bottom forks and take the place of the fork ends of a bicycle frame; the hubs of the wheels are attached to the ends of the levers instead of the fork ends of the bicycle, and springs provided at the other ends of the levers absorb the jolting due to unevenness of the roads.

In tires, probably the most interesting new invention is the Radax, a double tube tire, the essential

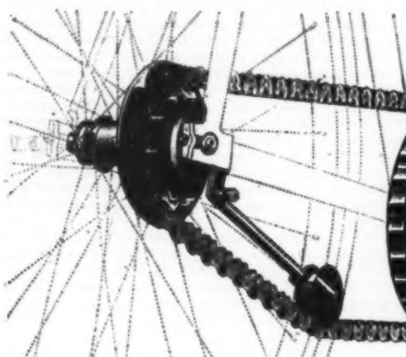


FIG. 4.

feature of which is the mode of attaching the cover. This is made to fit any of the well-known standard makes of rim, and is entirely devoid of wires, bands, and thickened edges. Instead of these it has a larger amount of flap on the edges, and the fabric is woven in a peculiar manner, giving it a curvilinear form. This cover is remarkably easy to attach and detach. The makers are the Radax Pneumatic Tire Company, Manchester. Apart from this there is little to attract attention in connection with tires.

"Free wheel" cycles were to be seen on almost every stand at both shows. It is remarkable how suddenly the public taste for this machine has been developed. Tricycles having free pedals—which amount to the same thing—have been in use for some years. In these a pawl and ratchet wheel have sufficed for releasing the pedals. Then there came the Protean gear, to which is probably due the present free wheel movement. This was first shown at the Stanley Show in 1894, and it was then predicted that in the near future all bicycles would be fitted with a free wheel. Disinterested expert riders appear to look upon the free wheel somewhat sceptically, for not only does its adoption in nearly all cases add materially to the complexity of the bicycle, but the clutches generally also introduce an amount of extra friction. One may here be tempted to ask, what are the advantages claimed for the free wheel machine? They are two: First, the saving of human energy by being able to keep the legs stationary when no effort is required, such as in coasting; and, secondly, a motionless pedal when dismounting.

Against these there is to be set off the introduction of two somewhat delicate clutches and an additional brake. Although a large number of cycle makers have tried their hands at producing an original free-wheel clutch mechanism in most cases, the products evolved bear remarkable similarity to one another. Generally speaking, they are devised upon one or two well-known mechanical methods, i. e., the friction clutch and the pawl and ratchet wheel. The latter being objectionable on account of the "clicking" noise produced by the passage of the pawl over the serrated wheel, friction has been largely resorted to. Among the devices of this pattern, probably the Morrow clutch (Fig. 1) commands the largest amount of public favor. In this clutch there are two rings, an inner and an outer. The inner ring is secured to the hub, and has cut in its periphery a number of taper grooves, in each of which is a roller, block, and spring. The outer ring carries the chain teeth. When forward pressure is applied to the pedals, each roller tends to move toward the narrow end of the cavity, and the chain wheel is thereby jammed tight on the central disk, which is secured to the hub. If, however, the hub tends to move faster than the chain wheel, each roller moves toward the wide end of its cavity and the frictional connection is interrupted. The blocks and springs are provided in order that the clutch shall become effective immediately a forward driving effort is exerted.

The provision of a device of this nature, it need scarcely be observed, deprives the rider of his retarding power—back pedaling—and it is therefore necessary to supply an extra brake to take its place. This is done in several ways. In some cases another clutch is provided on the crank shaft, which, with a backward pressure on the pedals, operates a cam, which in turn exerts a pull on a brake working either on the rim, tire, or hub of the back wheel. Starley & Company have adapted the Morrow clutch to a hub brake of ingenious design, whereby with an extra back pressure on the pedals the brake is applied. This has the additional advantage that the machine can be wheeled backward, which is feasible with scarcely any other back-pedaling device. Many of the rear-wheel clutches are based largely on the design of the Morrow, but the Otto clutch is entirely different, and appears to be based on the action of a chain pipe cutter, the expanding ring being built up of links. Garrards, of Birmingham, have also designed a combined free-wheel clutch and brake.

The Whippet Cycle Syndicate, Limited, the originators of the Protean gear, have embodied in the Whippet bicycle a free wheel, back-pedaling brake, and a new variable speed gear, the combination of which is of considerable interest. The accompanying illustrations will enable it to be readily understood. The ratchet clutch (Figs. 2 and 3) drives from four points simultaneously, and when running freely it revolves in ball bearings, so that there is, in all conditions, a minimum of friction. The back-pedaling rim brake is actuated by a projection on the chain wheel engaging with a lever underneath the main bearing at only one point in the revolution of the pedals. The

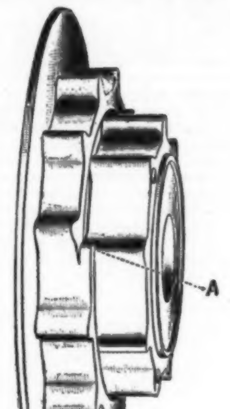


FIG. 5.

change of gear while running is effected by the following means: On the rear hub are placed two chain wheels (Fig. 5) secured together and mounted on the free wheel. The side of the larger hub-chain wheel, at the point marked *A*, has a projection or step. A fork embraces the chain to determine its position without touching it except when the alteration is being made. This fork is capable of sliding sideways; that is to say, it can guide the chain on to either the large or small wheel, and is operated by a lever in a convenient position to the rider. When the chain is on the smaller wheel, giving the high gear, and the rider desires the

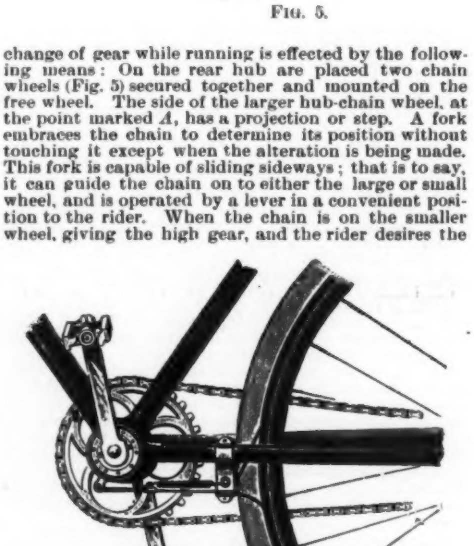


FIG. 6.

low gear, he moves the lever while he is riding, which guides the chain toward the large wheel. When the step, *A*, comes into the opening of the chain it engages the part of the chain that is coming on to the wheel and lifts it up without jerk or of noise on to the larger diameter, and there it remains until the rider wishes to change again to the high gear. When the change is made from the low to the high gear, the fork is moved in the opposite direction, guiding the chain toward the small chain wheel. The front chain wheel (Fig. 4) is of double width, so as to allow the chain to find its own position and maintain true alignment. The chain, it

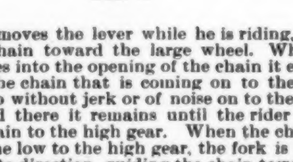


FIG. 7.

will be observed, is of special construction as regards the side links.

The interest in the brake question has been considerably revived by the free-wheel craze. A decided novelty in this connection is the rim band brake invented by Mr. Lamplugh (Figs. 6 and 7). The principal of the brake consists primarily in utilizing the whole of the periphery of the rim as the braking surface. To do this a band of thin metal of the shape shown in Fig. 7 is employed, being held to the ordinary rim by inflation of the tire. Around this is placed a strong vulcanized hempen cord, fixed at one end, and passing round the channel through a roller to a small lever on the handle bar. By this means is obtained a braking power that can be applied to any desired de-

gree without damaging either the rim, tire, or machine. The small pressure on the operating lever by tightening the band round the whole rim simultaneously gives a remarkable degree of retarding force. This system can be applied equally well to either the front or back wheel and can be operated in any known manner. It is made by the Barford Manufacturing Company, Birmingham.

HEAVY DUPLEX LATHE.

THE engraving given herewith illustrates a very powerful patent duplex shafting lathe recently completed by Messrs. Hulse & Company, Limited, of Ordsal Works, Manchester, for dealing with shafting of the heaviest class, gun forgings, etc., and specially arranged to be driven by an electric motor mounted on the fast headstock. The lathe, which has 40-inch centers, is arranged so that four cutting tools may be in operation simultaneously, viz., two at the back and two at the front of the lathe.

The bed is made with two deep longitudinal box girders united by numerous transverse box bars which give great strength and rigidity. The fast headstock is provided with single and two treble gears and two changes of speed by sliding spur pinions on the first motion shaft. As the speed of the motor is variable between about 225 and 450 revolutions per minute, it will be seen that any required speed of rotation may be readily obtained, so as to suit resistances to be overcome, which of course, vary according to the size and nature of the work and the amount of metal to be removed.

The motor is connected with the gearing of the fast headstock by pinion and intermediate wheels, which are all accurately machine cut, and which run very smoothly and noiselessly, even when the motor is on its highest speed. The main spindle is of steel, with hard gun-metal adjustable bearings of square outline, the back bearing being multiple, grooved for resisting, without undue friction, the end thrust; the face plate chuck is of cellular construction, fitted with four steel jaws operated by independent screws for gripping the work.

The lathe is fitted with two sliding carriages, each carrying a pair of duplex compound slide rests and two cutting tools, or four in all. Each tool is capable of taking a cut $1\frac{1}{2}$ inch deep and about $\frac{1}{4}$ inch thick, at the rate of 6 to 7 lineal feet per minute, which if maintained continuously, would yield about 5 hundredweight of steel turnings per hour for each tool, or a total weight of 10 tons of steel removed by the tools per day of ten hours.

The sliding carriages possess several noticeable features in their mechanical arrangement. They are operated by twin-fixed guide screws placed one on each side of the bed, worked by rotating nuts driven by a central shaft. The arrangement prevents horizontal cross-winding of the carriages on the bed, and diminishes the friction which results from working with a single rotated guide-screw, as in the usual practice. The central driving-shaft is rotated through change wheels driven by the main spindle of the fast headstock; the direction in which the nuts rotate is regulated on each carriage independently by means of a clutch which enables each carriage to be traversed in either direction, and this is an additional advantage accruing from the arrangement of stationary instead of rotating guide-screws.

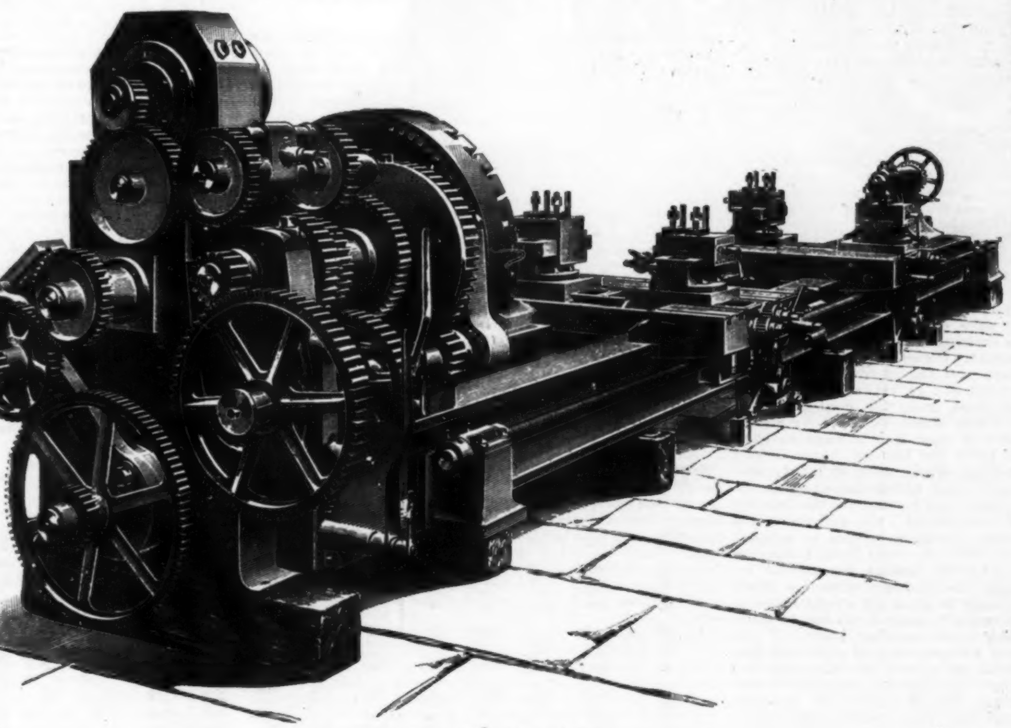
Each carriage is fitted with its own independent gear for surfacing and tapering by means of swing frame and change wheels carried at the back. By this means one carriage may be sliding along the body of a shaft at, say, $\frac{3}{4}$-inch traverse, while the rests on the other sliding carriage are surfacing at, say, $\frac{1}{16}$ inch. For turning taper objects the surfacing feed may be varied in ratio to the sliding traverse to suit the taper required.

For moving the sliding carriages quickly by power to any position along the bed, the central shaft is readily disconnected from the feed gear by a clutch operated by a lever placed in a convenient position at the front of the lathe, the shaft being quickly rotated by bevel gear and fast and loose pulleys self contained with the lathe.

The movable headstock has a large steel cylinder actuated by screw and wormwheel, for forcing the center into the work, and actuated by a handwheel, direct on the screw, for quickly moving it in and out. It is arranged so that it may be coupled to one of the sliding carriages in order that it may be quickly traversed with it to any position along the bed by power.

The lathe, as will be seen, is very massive and well proportioned, and the company has made them up to 100 feet in length, with two, three, and four sliding carriages on the bed, viz., with four, six, and eight tools respectively. Many have been constructed as double lathes, viz., with two feet and two movable headstocks, the fast headstocks being placed at the opposite ends of the bed. These double lathes are so arranged that either the right or left-hand fast headstock may be coupled up so as to drive one, two or three of the sliding carriages to suit the work which has to be dealt with; as an example, one fast headstock may be driving three sliding carriages operating on a large shaft, while the other fast headstock might be driving a sliding carriage operating on a short piece of work between centers, or surfacing an object held in the faceplate chuck.

Nearly all the leading steel manufacturers in this country have one or more of these patent lathes installed in their works, and many have also been supplied for ordnance and marine engineering work.—Engineering.

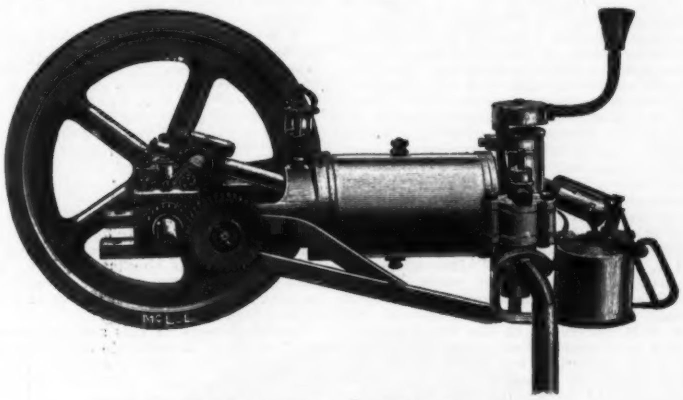


HEAVY DUPLEX LATHE.

THE McLACHLAN HEAVY OIL MOTOR.

THE accompanying illustration shows the McLachlan horizontal petroleum motor. The makers—the E. A. McLachlan Engine Company, of 114 Holborn Viaduct, E. C.—claim to have producted a heavy oil engine that is in every way a success, the fuel used being ordinary paraffin. The motor is made in both vertical and horizontal forms, and in a variety of sizes, ranging from $2\frac{1}{4}$ horse power up to 7 horse power. For motor cycles or light cars the company recommend their vertical engines, Nos. 1 and 5, of $2\frac{1}{4}$ and $2\frac{3}{4}$ horse power respectively, which are of the well-known De Dion type. No carburetor is necessary; the oil is supplied by gravitation and is at once vaporized, giving exceptional power to the explosions. The horizontal engines work on the same method, and are made $2\frac{3}{4}$ horse power to 7 horse power, with either single or double cylinders according to the power of the engine desired. The driving weight capacity of the largest size of this pattern engine is one ton. The cost of running these engines is described as being purely nominal, and to drive the above weight the consumption of oil would be about three pints of paraffin per hour (which can be bought at 6d. per gallon) or less than 3d. for one hour's work.

The McLachlan Company claim that there is hardly any noticeable smell with these heavy oil engines—in fact, none when the car is running—and owing to the special method of vaporizing there is no clogging in the cylinder. Simplicity is another feature of these engines, there being only two valves—an automatic



THE McLACHLAN HEAVY OIL MOTOR.

admission valve and an exhaust valve controlled by a rocking arm actuated from a small cam shaft. The motor can be fitted with either electric or tube ignition, as desired.

In addition to the above engines the McLachlan Company are manufacturing specialties in electric plants complete, suitable for recharging accumulators, lighting, etc. One of their special lines for country shops is a heavy oil motor engine and dynamo, fixed upon an iron bed 6 feet long by 2 feet broad. The plant is capable of lighting up a shop or house with fourteen or sixteen incandescent lights of 16-candle power, or for recharging. The engine runs at 1,500 revolutions per minute, the dynamo giving out 60 volts and from 18 to 20 amperes. The weight of this special outfit is about 11 cwt. We are indebted to Industries and Iron for the engraving and description.

FACTORY HEATING.

THERE is no doubt but that of late years the problem of keeping the factory warm during the winter has been duly considered by the majority of progressive factory owners, and those who have tried it thoroughly have no doubt found it to pay, but there seems to be many yet who do not seem to seriously consider the warning problem much further than to keep the office comfortable

If we leave out altogether the humane principle that should induce a man to have his workmen comfortably housed during the winter if possible, we still have plenty of argument in the cause, for it is good business, and an investment in warming apparatus will pay, inasmuch as it insures more work, better work and better humored men all around—an essential feature in the smooth operation of any factory. Men can do rough labor, and by hustling like fury keep warmed up themselves in tolerably cold weather, but when we come to consider this item in running a factory we find

that the rough labor is the cheap work, and that the men who by virtue of their skill in special lines command good wages are the very men who are handicapped in their work when the temperature gets down uncomfortably near the zero point. These are the men whose loss, in time, temper and inability to get satisfactory results out of machines or material, will count up on the financial argument for a heating system for the factory in winter.

As to methods and systems for heating, there is room for argument without end, and if one were to consider them in an abstract sense it might be a toss up to decide, but usually there is some individuality in each factory and its operations that is a factor in reaching a decision, and those contemplating such a departure should study methods with a view to adapting them to their individual requirements, instead of in an abstract way. In competitive essays on house warming we are introduced to some half a dozen systems and combinations, consisting of steam—at high and low pressure, hot water ditto, hot air and some combinations. Heating with air is given as the oldest method, and its introduction is set by one authority as some time about 1758, or a couple of decades before the origin of steam as an agent for both heat and power, but the historically inclined may have a dim memory of some ancient ruins in which there was evidence of efforts to keep the building warm by having a fire on the outside and an air tunnel running into the house, and this would antedate the accredited introduction by several centuries. It's queer, isn't it, how we take up old ideas and modernize them? But any way, we may wade through the whole file of house warming manuals and not find just what we want for a factory heating system, because there is a wide difference in the requirements, and there is also a lot of wasted heat going out the exhaust at many of our factories that could as well be used at a small outlay in pressure, and no other method of heating should be thought of as long as this exhaust is going to waste. It requires some study, though, and systematic work to handle exhaust steam for the best results with the least additional labor for the engine. In fact, it is a very simple question to handle live steam as compared to it, for in the use of live steam it is easy enough to have branch pipes and valves for regulating the supply to the requirements of each department separately, while in the use of exhaust, when you go to throttling down at any point you are screwing back pressure onto the engine. Suppose, for example, that you start out to heat only one department at first, you pipe with a view to draining back the water and all that, and put a back pressure valve at about five pounds on the open air exhaust and send the steam through the heating system. Then, if the other departments are directly above this one, you may continue the system up through the factory and still get very good results. This is by reason of the fact that heat goes up, and though the first department through which the system passes gets the lion's share of the heat, it passes from there up and helps in a manner to warm the upper stories. Now, if the factory consists of several wings, and we start in to heat all of them with exhaust, we begin to understand the imperfections of the system. If we run a single system the first department will be uncomfortably warm when those on the tail end of the system are still cool, for all the steam that goes throughout the plant must pass through the nearest departments first on its journey. To secure a better distribution of the heat it is the usual practice in large plants to compound the system, and to do this and not necessitate an increase in the back pressure requires some care, not only in construction, but also in operation, but it may be done, and where the factory is so large that in very severe weather the exhaust will not supply sufficient heat, it is a very simple matter to supplement it with live steam.

Where the exhaust is required for some special service about the factory other than that of supplying heat for the building, the question simmers down to an issue between live steam and hot air as agents for supplying heat, and where both have to be produced independently it is rather a hard question to decide between the two. There is one thing that must be borne in mind, though, and that is that you have got to use fuel to produce all the heat you send up in the factory, no matter what agent you use—unless it is the exhaust, and in that you simply save what would otherwise go to waste, and saving is making in itself. Even if you draw some of the apparently useless heat from in front of and around the boilers and fan it up through the building, the air blown out will be replaced with cool air, and it all takes up heat from the coal that you think you are using to make steam only. Live steam has one thing in its favor in that it is always so that you can turn it on and have the factory warm before work time in the morning, while with exhaust, and with hot air distributed by fan, unless driven by an independent engine, you have got to wait till the factory starts before you start in warming it up, and there is a period of early morning frostiness. This is a point that might well receive more attention from managers of some plants who may be fooling themselves by thinking they have got the heating question down fine, while in fact they may be running a cold shop at the very time of day when it is most desirable to have it nice and comfortable—the opening hour. If the manager of such a plant will get out and catch the first cars out toward his works on a cold morning, like his men do, and then go into the factory with them and shuck himself for work as they do, and come in again at noon and eat lunch with them while the shop is standing and getting so cold that all are shivering, he will likely get some good ideas of just what constitutes a properly warmed factory.—Age of Steel.

THE WEIGHT OF AIR.

The properties of air and other gases are so different from the properties of the solids and liquids that we can see and measure and handle so readily, that it is not at all to be wondered at that the earlier men of science regarded gases as intrinsically different, in their very essence, from the more familiar and tangible things of our daily experience. The word "gas" was invented by a Belgian chemist named Van Helmont, in the first half of the seventeenth century; and while it is not definitely known where he obtained the suggestion from which the word took form, it is not at all unlikely that it came from the Dutch word "geest," which means "a spirit," and which is related to our common English word "ghost." Whatever the origin of the word, it is certain that the early philosophers considered gases to be essentially different from the other materials of which the world is composed. We do not need to discuss the views that they held about these things, beyond stating that until the year 1644 it does nor appear to have occurred to anyone that gases (and, in particular, air) possess the property of weight. But in that year the Italian physicist, Torricelli, invented the barometer, and proved, by conclusive experiments, that air, at least, has weight, just as all the more substantial bodies have; and now, of course, we know that every mass of gas has a perfectly definite weight.

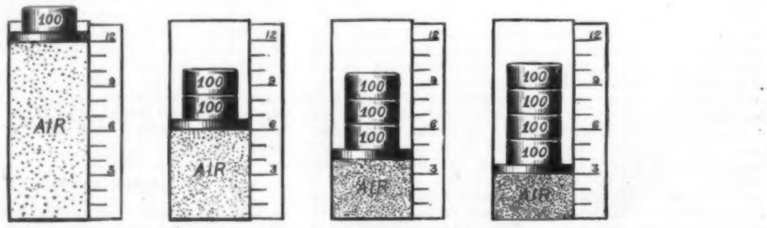
It is not essential to our present purpose to describe, in detail, the experimental methods by which the air has been weighed. It will be sufficient to say that the general process consists in weighing a balloon-shaped flask twice—the first weighing being performed with the flask full of air, while the second is performed after the air has been all pumped out. If air had no weight at all, these two experiments would give identical results; but it is found that, as a matter of fact, the flask is always sensibly heavier when it is full. By taking the differences of the two weighings, we therefore ascertain the weight of the quantity of air that is just sufficient to fill the flask. Knowing this, we next proceed, by means of a separate experiment, to find out the volume of the flask, in cubic inches; and when this has been done, we are in position to calculate the weight of a cubic inch of air, or of a cubic foot of it, or of any other quantity.

Measurements of this sort are exceedingly delicate, and they can be valuable only when performed by experienced men, with the aid of the finest apparatus that can be made. Regnault, whose skill cannot be doubted, and whose apparatus was beyond reproach, found that at the freezing point of water, a cubic centimeter of perfectly pure, dry air weighed 0·0012932 of a gramme, when the barometer stood at 76 centimeters, in his laboratory at Paris. To make this result available for practical work in this country, we have reduced these figures to their English equivalents; and we find that at ordinary atmospheric pressure, and at the temperature of melting ice (32° Fahr.), a cubic foot of air weighs 0·080681 of a pound.*

It will be observed that we have carefully specified the pressure and temperature of the air, in giving its weight. That is because the density of the air varies when these elements vary, unless certain conditions are fulfilled. If a given constant mass of air be compressed, or heated, or modified in any other way, its weight will remain unchanged, just as the weight of any other substance would remain unchanged under similar circumstances. The reason that the weight of a cubic foot of air varies so much under varying conditions of temperature and pressure is, that air is exceedingly expansible and compressible. Suppose, for example, that we had a light steel flask, with a capacity of precisely 1 cubic foot, and that we filled this box with air at the usual atmospheric pressure, and (say) at 70° temperature. The air so confined would have a certain definite weight. Suppose, next, that we pump more air into this flask, until there is perhaps three times as much air in it as there was before. In pumping in this extra air, we shall materially increase the pressure within the flask; but that does not concern us for the moment. The point that we wish to make is, that the air that was originally in the flask weighs just exactly the same as it did before—no more and no less; but the total weight of the air in the flask is now greater than it was before, because we have forced a good deal more air into this 1 cubic foot of space than there was in it in the first place; and that is the reason (and the only reason) why a cubic foot of air at a higher pressure weighs more than a cubic foot of air at a lower pressure. There is simply more air crowded into this cubic foot at the higher pressure.

The first experimenter to investigate the behavior of air, under varying pressures, with anything like accuracy, was the English physicist, Robert Boyle, who discovered the fact of nature now known under the name of "Boyle's law." As this law is of constant use in connection with steam engineering and other allied branches, it will be worth our while to give some account of it. The law is very simple, and will be readily understood by referring to the illustrations which accompany this article. On the left we have endeavored to represent a metal cylinder, standing on end, in which a definite mass of air is confined by means of a weightless piston which fits the cylinder perfectly, and yet without the least friction. We cannot realize, in practice, the condition of an airtight piston which is at the same time perfectly frictionless; but our limitations in this regard need not prevent us from imagining such a thing, nor from learning something about what the behavior of air would be, if such a state of affairs could be realized. For the sake of further simplicity, we will also suppose that the external air does not press down upon the piston at all, but that the only force tending to confine the air is that due to the 100-pound weight which is represented in the engraving. This amounts to assuming that the whole experiment that we are about to describe is performed in a closed chamber from which the air has been removed by a suitable pump. In practice such experiments are performed in the open air, and the effects of the external atmospheric pressure are allowed for in the calculations. We could pursue this latter course if we chose to, but as we are not going to actually perform the experiment, but only to think of its being performed, we might as well think of the external atmospheric pressure as being entirely done away with, by some such means as we have suggested; for this will save all complication, and enable us to give our undivided attention to the one thing that we wish to illustrate.

We have, then, a metal cylinder in which a certain definite amount of air is confined by means of a tight fitting but frictionless piston; and the only force tending to hold this air confined is that exerted by the 100-pound weight which rests upon the piston. We will suppose that the quantity of air within the cylinder has been regulated so nicely that the weight is held by it at such a height that the bottom of the piston is precisely 12 inches from the bottom of the cylinder. If



ILLUSTRATING "BOYLE'S LAW."

* By "ordinary atmospheric pressure" we mean the pressure that would be exerted by a weight of 14·7 pounds, resting upon a base 1 inch square, at sea level in the latitude of Washington; and throughout this article when we use the word "pound" it is to be understood that the data relate always to sea level, at Washington. We make this explanation in order to guard against possible criticism; but for the purposes of engineering, no attention need be paid to this foot note, and the figures that we give may be used in any latitude, without fear of sensible error. The tables are supposed to be correct for Washington; and if the force of gravity were constant all over the United States, they would be equally exact for all places in the country. As a matter of fact, the earth attracts bodies a little more strongly as we go north, and a little less strongly as we go south; so that it is not possible to make a table that shall be strictly accurate for all places. The greatest amount by which the tables can be in error from this cause, however, when they are applied to any part of the United States north or south of the latitude of Washington, is only one-ninth of one per cent,—this maximum error occurring at Key West.

TABLE I.—ABSOLUTE WEIGHT OF A CUBIC FOOT OF AIR, IN POUNDS.

Temp. of Air, on Fahrenheit, Scale.	Pressure, in Pounds per Square Inch, above Atmosphere.															
	0 lbs.	5 lbs.	10 lbs.	15 lbs.	20 lbs.	30 lbs.	40 lbs.	50 lbs.	60 lbs.	70 lbs.	80 lbs.	90 lbs.	100 lbs.	125 lbs.	150 lbs.	200 lbs.
Deg. 0	0·0863	0·1156	0·1450	0·1744	0·2037	0·2624	0·3211	0·3798	0·4385	0·4972	0·5559	0·6146	0·6733	0·8201	0·9669	1·2604
10	·0845	·1132	·1419	·1706	·1994	·2568	·3143	·3717	·4292	·4866	·5441	·6015	·6590	·8024	·9462	1·2335
20	·0827	·1108	·1390	·1671	·1952	·2515	·3077	·3640	·4202	·4765	·5328	·5891	·6453	·7859	·9265	1·2078
30	·0810	·1085	·1361	·1636	·1912	·2463	·3014	·3566	·4117	·4668	·5219	·5770	·6321	·7699	·9076	1·1832
40	·0794	·1064	·1334	·1604	·1874	·2414	·2954	·3494	·4034	·4574	·5114	·5654	·6195	·7545	·8895	1·1595
50	·0778	·1043	·1308	·1572	·1837	·2367	·2896	·3426	·3955	·4485	·5014	·5544	·6073	·7397	·8721	1·1368
60	·0763	·1023	·1283	·1542	·1802	·2321	·2841	·3360	·3879	·4398	·4918	·5437	·5956	·7254	·8553	1·1149
70	·0749	·1004	·1258	·1513	·1768	·2278	·2787	·3296	·3806	·4315	·4825	·5334	·5844	·7118	·8391	1·0939
80	·0735	·0985	·1235	·1485	·1735	·2235	·2735	·3236	·3736	·4236	·4736	·5236	·5736	·6986	·8236	1·0736
90	·0722	·0967	·1213	·1458	·1704	·2195	·2686	·3176	·3658	·4159	·4650	·5140	·5631	·6859	·8086	1·0541
100	·0709	·0950	·1191	·1432	·1673	·2155	·2638	·3120	·3602	·4084	·4566	·5049	·55 1	·67·6	·7942	1·0353
110	·0697	·0933	·1170	·1407	·1644	·2118	·2591	·3065	·3539	·4013	·4486	·4960	·5434	·6618	·7802	1·0171
120	·0684	·0917	·1150	·1383	·1616	·2081	·2547	·3012	·3478	·3943	·4409	·4875	·5340	·6504	·7668	0·9996
130	·0673	·0902	·1130	·1359	·1588	·2046	·2504	·2961	·3419	·3877	·4334	·4792	·5250	·6394	·7538	·9828
140	·0662	·0887	·1112	·1337	·1562	·2012	·2462	·2912	·3362	·3812	·4262	·4712	·5162	·6287	·7412	·9663
150	·0651	·0872	·1094	·1315	·1536	·1979	·2422	·2864	·3307	·3750	·4192	·4635	·5078	·6184	·7291	·9504
160	·0640	·0858	·1076	·1294	·1511	·1947	·2382	·2818	·3254	·3690	·4125	·4560	·4996	·6084	·7173	·9351
170	·0630	·0854	·1059	·1273	·1487	·1916	·2345	·2773	·3202	·3630	·4059	·4488	·4916	·5988	·7059	·9203
180	·0620	·0831	·1042	·1253	·1464	·1886	·2308	·2730	·3152	·3574	·3996	·4418	·4840	·5894	·6949	·9059
190	·0611	·0818	·1026	·1234	·1442	·1857	·2272	·2688	·3103	·3519	·3934	·4350	·4765	·5804	·6842	·8920
200	·0601	·0806	·1011	·1215	·1420	·1829	·2238	·2647	·3056	·3465	·3875	·4284	·4693	·5716	·6739	·8784
210	·0592	·0794	·0996	·1197	·1399	·1802	·2205	·2608	·3111	·3414	·3817	·4220	·4623	·5630	·6638	·8653
220	·0584	·0782	·0981	·1179	·1378	·1775	·2172	·2 69	·2966	·3364	·3761	·4158	·4555	·5548	·6540	·8526
230	·0575	·0771	·0967	·1162	·1358	·1749	·2141	·2532	·2923	·3315	·3706	·4097	·4489	·5467	·6446	·8402
250	·0559	·0749	·0939	·1130	·1320	·1700	·2080	·2461	·2841	·3221	·3602	·3982	·4362	·5313	·6264	·8166
275	·0540	·0724	·0907	·1091	·1275	·1642	·2011	·2377	·2744	·3112	·3479	·3847	·4214	·5133	·6051	·7888
300	·0522	·0700	·0878	·1055	·1233	·1588	·1944	·2299	·2654	·3010	·3365	·3720	·4075	·4964	·5852	·7628
325	·0506	·0678	·0850	·1022	·1194	·1538	·1882	·2226	·2570	·2915	·3258	·3402	·3946	·4806	·5666	·7386
350	·0490	·0657	·0823	·0990	·1157	·1490	·1824	·2157	·2490	·2824	·3157	·3490	·3824	·4657	·5491	·7158

TABLE II.—ABSOLUTE WEIGHT OF A CUBIC FOOT OF AIR, IN POUNDS, AT 32° AND 212°.

Pressure in pounds per square inch, above atmosphere.	Temperature (Fahr.). 32°	Temperature (Fahr.). 212°	Pressure in pounds per square inch, above atmosphere.	Temperature (Fahr.). 32°	Temperature (Fahr.). 212°
0	0·0807	0·0591	25	0·2179	0·1595
1	·0862	·0631	30	·2453	·1796
2	·0917	·0671	35	·2728	·1997
3	·0971	·0711	40	·3002	·2198
4	·1026	·0751	45	·3277	·2399
5	·1081	·0792	50	·3551	·2600
6	·1136	·0832	60	·4100	·3002
7	·1191	·0872	70	·4649	·3404
8	·1246	·0912	80	·5198	·3805
9	·1301	·0952	90	·5746	·4207
10	·1356	·0993	100	·6295	·4609
11	·1410	·1033	110	·6844	·5011
12	·1465	·1073	120	·7393	·5413
13	·1520	·1113	130	·7942	·5815
14	·1575	·1153	140	·8490	·6216
15	·1630	·1194	150	·9039	·6618
16	·1685	·1234	160	·9588	·7020
17	·1740	·1274	170	1·0137	·7422
18	·1795	·1314	180	1·0686	·7824
19	·1850	·1354	190	1·1235	·8226
20	·1904	·1394	200	1·1784	·8627

there is no leakage past the piston, and no change in the temperature of the air, the system will remain balanced in this precise condition forever (so far as we know).

Now, suppose that another 100-pound weight is placed upon the piston. The piston will be immediately forced downward by the additional weight, and the air under it will be compressed, and the pressure that the air exerts against each square inch of the cylinder and the piston will be greater than it was before. There will be various effects produced at the outset, besides the mere reduction of the air to a smaller volume. For example, small currents will be set up in the air, and the air will also become more or less heated. If we wait, however, until all these currents have died out, and the air has cooled again to its original temperature, we shall find that the piston comes finally to rest at a position such that its lower side is almost precisely 6 inches from the bottom of the cylinder instead of 12, as it was originally. That is, by doubling the pressure upon the air, we have reduced the volume of the air to one-half of what it was at first—always understanding that the temperature of the air is precisely the same in both cases. If we had loaded the piston with 300 pounds, we should have found that when the system finally came to rest, the volume of the enclosed air would be one-third of its original volume. If we had piled 400 pounds on the piston, we should find that the volume would be reduced to one-fourth of its original value, as shown on the extreme right of the engraving; and so on, for all ordinary pressures. This fact, that the volume of air (or of any other of the so-called "permanent gases") is halved by doubling the pressure, and so on, (provided the temperature of the air remains constant), is known as "Boyle's law."

It will be plain, upon examining the engraving, why the weight of a cubic foot (or of a cubic inch) of air varies with the pressure; for under a load (or pressure) of 400 pounds, the same air is forced into a space only one-fourth as great as it occupied under a load of 100 pounds; and therefore its density (or, in other words, its weight per cubic foot, or per cubic inch), is four times as great at the higher pressure.

We have referred several times to the necessity of keeping the temperature of the air constant during experiments of this kind, if "Boyle's law" is to be illustrated. We shall now explain, briefly, what happens when the temperature of the air is not kept constant; and we shall find that the effects of change of temperature are almost equally as simple as the effects of change of pressure. In the interest of simplicity it will be well to state, at the outset, that physicists are in the habit of reckoning temperatures, not from the arbitrary zero of the Fahrenheit scale, but from a point which is approximately 460 Fahrenheit degrees below this zero. The scientific starting point, or zero, so determined, is called the "absolute zero," because it is believed to be the temperature at which all bodies are totally destitute of heat; and temperatures reckoned from this "absolute zero" are called "absolute temperatures." To illustrate: The freezing point of water, on the ordinary Fahrenheit scale, is at 32°; and the "absolute temperature" of this point will therefore be $460° + 32° = 492°$. Again, the boiling point of water, under one atmosphere pressure, is 212° on the ordinary Fahrenheit scale; and therefore the "absolute temperature" of this point is $460° + 212° = 672°$.

With this much understood, we are now prepared to state what is known as "Gay Lussac's law" (or "Charles' law"); which is, that if the pressure exerted upon a given mass of air (or any other "permanent gas") be kept constant, the volume of the air (or gas) will vary proportionally to the "absolute temperature" of the gas. For example, consider the second of the engravings accompanying this article, where the air is confined by a total weight of 200 pounds. Let us suppose that this air, at the outset, is at the freezing point, or at 32° on the ordinary Fahrenheit scale; and let us imagine the air to be heated, in some way, until its temperature becomes 524° on this same scale, the load of 200 pounds being kept constant all the while. To find out how much the air will expand under these circumstances, we first convert the ordinary temperatures, given above, into "absolute temperatures, by adding 460° to each of them. We have $460° + 32° = 492°$, and $460° + 524° = 984°$. Now "Gay Lussac's law" states that so long as we keep the pressure constant, the volume will increase proportionally to the "absolute temperature"; and since 984 is just twice as great as 492, it follows that the air will expand, under the stated conditions, until its volume is precisely double what it was at the beginning. That is, the mass of air shown in the second illustration will push up the load of 200 pounds until the piston comes into the position shown in the first of these illustrations.

By means of the laws of Boyle and Gay Lussac, we can calculate the way in which the volume of a given mass of air will vary under any imaginable circumstances of pressure and temperature, and hence we can calculate how much a cubic foot of air will weigh at any proposed temperature and pressure, when we once know, by experiment, how much such a volume of air will weigh under certain definite standard conditions—say at one atmosphere pressure, and at the temperature of freezing water. Regnault's labors, referred to earlier in this article, showed that a cubic foot of air exposed to a pressure of 14·7 pounds per square inch and a temperature of 32° Fahr., weighs 0·080681 of a pound (or 1·29 ounces); and from this as a starting point, we have calculated the appended tables by means of the two laws above described—namely, the laws of Boyle and of Gay Lussac.

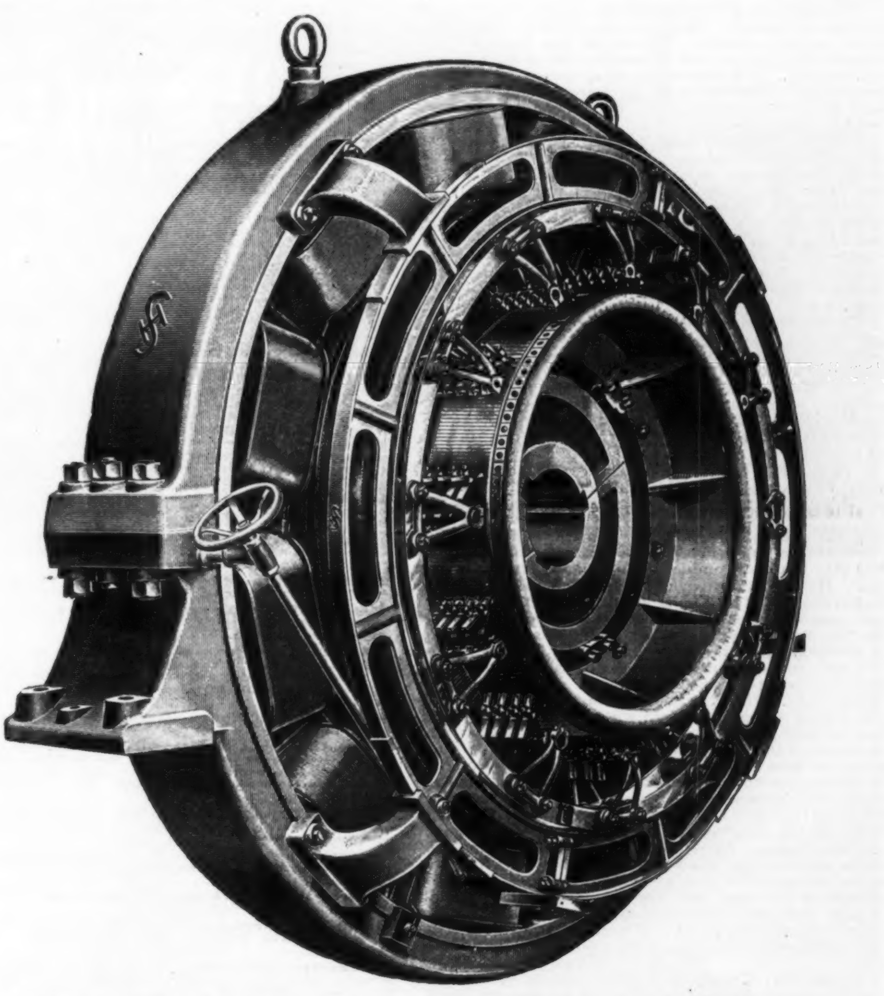
The tables do not call for much explanation, except as to the precise meaning of the phrase "weight of a cubic foot of air." It is to be understood that the weights here given are the absolute weights of the various masses of air, no allowance being made for the buoyancy of the surrounding atmosphere. The atmosphere that surrounds us buoys up everything that is submerged in it, just as water does, only not to so great an extent. If a cannon ball is submerged in water, the water buoys it up by an amount which is precisely equal to the weight of a mass of water having identically the same size and shape as the cannon ball itself; and when the cannon ball is submerged in air, instead of in water, the surrounding air buoys up the ball by an amount which is precisely equal to the absolute weight of a mass of air having the identical size and shape of the cannon ball; and so on with any other fluid or gas, whether it is water or milk or mercury or carbonic acid gas or coal gas or anything else. If a cubic foot of air be enclosed in an air-tight case and then weighed in a vacuum, it will have the weight that is given in the table for its particular condition of temperature and pressure; but if it is weighed in air instead of in a vacuum, it will appear to weigh less by an amount equal to the tabular weight of an equal volume of air at atmospheric pressure. For example, it will be seen that the actual absolute weight of one cubic foot of air at a temperature of 70° Fahr. and a pressure of 80 pounds per square inch above the atmosphere, is 0·4825 pounds; but if this were weighed while surrounded by air at 70° and at ordinary atmospheric pressure, it would be buoyed up by an amount equal to the weight of an equal volume (that is, 1 cubic foot in the present case) of the surrounding air. Now, according to the tables, a cubic foot of the surrounding air weighs 0·0749 pound under the conditions given; and hence the apparent weight of the given cubic foot of air will be only $0·4825 - 0·0749 = 0·4076$ pound.

In all calculations concerning the heating and ventilating of buildings, the flow of air through pipes, the air required for combustion, and so on, it is necessary to use the absolute weight of the air considered; and that is why the absolute weight has been given in the tables. If the apparent weight should be wanted for any purpose (which is not likely), it can be obtained from the tables by making the proper allowance for buoyancy, as explained in the preceding paragraph; but for all the ordinary problems of engineering, the values as given directly by the tables should be used.

A special table has been given for the temperatures 32° Fahr. and 212° Fahr., as these temperatures occur in engineering calculations so frequently that separate tabulation appear to be desirable. This auxiliary table does not differ from the main one in its nature, and is to be regarded simply as supplementary to it.—The Locomotive.

A NEW DIRECT CURRENT GENERATOR.

The illustration presented herewith is a reproduction from Für Alle Welt of a new dynamo-electric machine made by the well-known firm of Siemens & Halske. The machine is of the twelve-pole type and is directly coupled to the driving engine. The magnet-frame is made in two pieces and is bolted to separate base plates. The armature is carried by the extended shaft of the engine, the shaft being supported by special auxiliary bearings in addition to the usual bearings. The brush-carrier, consisting of a ring supported by arms, is secured either to the magnet-frame or the auxiliary bearings depending upon the conditions under which the machine is to be used. The brush-carrier can be adjusted by means of a screw-shaft provided with a hand-wheel. In machines of this kind drum armatures are used, the cores of which are composed of thin sheet-iron.



TWELVE-POLE, DIRECTLY COUPLED, CONTINUOUS-CURRENT DYNAMO.

HOW TO KEEP WARM IN COLD WEATHER.

There are all sorts of ways of preventing the undue loss of bodily heat in cold weather, but the best of all, according to M. Gabriel Prevost, who writes on the subject in La Science Française (December 8) is to do so "inside our own skins;" that is, to rely on the heat of our own bodies, keeping it in by proper treatment of the skin and increasing it by food and exercise, instead of wearing heavy clothes and living in overheated rooms. The preservative par excellence, M. Provost tells us at the outset, is to accustom oneself to low temperature; but this requires patience, prudence and good health. One cannot begin the treatment when very young, or when very old. It can be carried far, however, with the healthy adult, as is shown by the fact that savage races endure, while almost naked, temperatures that would kill the civilized man. In general, it may be said that we wear too heavy clothing. Says M. Prevost:

"The garment is to prevent the loss of heat. It has no 'warmth' in itself. . . . Its thickness is a negligible factor. A covering of paper, hermetically sealed at neck and wrists, and separated from the body by a layer of air, would be 'warmer' than three or four thicknesses of flannel close to the skin. . . . The ideal garment—preservative and at the same time hygienic—would be that which, without keeping in the perspiration, should prevent the body from radiating

its heat. This ideal is approached by using several layers of garments."

But bodily heat is not always sufficient to keep us warm. There must be some heat from the outside. Here, too, we go to extremes usually. To prevent all radiation from the body, we should live habitually in an atmosphere at the temperature of 25°–30° C. [77°–86° F.], which is of course far too high. The maximum temperature of a room, M. Prevost says, should be 15°–18° C. [59° 64·5° F.]. The best heater is in our own bodies; whether we are cold or warm depends largely on what we eat.

"To increase bodily heat, sugar and generally fat substances should prevail. Alcohol is eminently deceitful in this regard, and has the real heating value of so many sheets of cigarette paper. Two lumps of sugar have a hundred times the heating value of a glass of brandy. In general, sugar, oil, butter, and fats are the best heating substances."

The external application of grease and fats is also useful, and is used by many peoples of the extreme North. These prevent the loss of heat due to evaporation from the skin and are also insulating.

The same subject is touched on in Good Health (December) by Dr. J. H. Kellogg, writing on "winter diseases." His conclusion is that we "smother ourselves with clothing." We should wear lighter garments, and in particular we should not wear wool next the skin. This advice, which runs counter to that given by most physicians, is thus justified by Dr. Kellogg:

"The clothing should not be so heavy as to cause the skin to perspire. Many people smother themselves with woolen clothing. The writer has become convinced that it is not best to wear woolen clothing next to the body. It is only people so extremely feeble that they ought to be kept in an incubator in order to be safe from the hardships of cold, who need to wear woolen next to the skin.

"The peculiarity of wool is that it absorbs a large quantity of water before it appears to be wet. Wool is highly hydroscopic, as the physicists would call it; on the other hand, linen becomes wet and shows it as soon as water comes into contact with it. A woolen cloth or garment, upon being dipped quickly into a pail of water and removed, will not appear to be even moistened, whereas a linen garment will be wet through instantly. Linen has not the hydroscopic property of woolen. The latter is also irritating to the skin, while linen is not."

The practical difference in these fabrics, Dr. Kellogg goes on to tell us, is that linen next the skin takes up moisture quickly and passes it on quickly, while wool takes up perspiration slowly and passes it on slowly. In the latter case, therefore, there is always a large quantity of moisture next the skin, the skin itself is saturated with moisture, and heat is given off easily. On this "very important point" Dr. Kellogg continues as follows:

"Dr. Hurtz, an eminent scientist of Vienna, has made extensive experiments with reference to the rate at which the skin gives off heat, and he finds that it does so almost twice as rapidly when moist as when dry, the reason for this being that the heat must be conducted to the surface before it can be given up. A dry skin is a poor conductor, but a moist skin is a good one. Heat is readily given off by both conduction and radiation when the skin is moist. Moisten the finger and pass it through the air; the finger cools quickly. By this means one can tell in which direction the wind is blowing. Wet the entire finger, and hold it up in the air; the wind causes evaporation to take place, and this cools that side of the finger. So it is with the whole body. When the entire surface is moist or damp, the heat is being thrown off with great rapidity, and one is likely to be chilled. With woolen underwear the moisture of the skin is retained for a long time, and since the heat is being constantly and rapidly brought to the surface and thrown off in this way, the surface of the skin becomes chilled, and the person is far more likely to take cold than if he wore linen, for the linen takes up the moisture and transmits it to the outer air, drying at once. Therefore, I am becoming more and more satisfied that linen clothing is better suited for every season of the year and for all persons, with the exception of those who are very feeble. This is not a new idea, for Priessnitz, that remarkable genius who proposed the use of cold water in the early days, also made this discovery with reference to the clothing."

Nature, Dr. Kellogg concludes, requires of us all a tax for wearing clothes, and this tax we have to work out in frequent cold baths, to give our skins the vigor and tone that the Indian gets by going without clothing altogether. In short, we should bathe daily in cold water to antagonize the enervating influence of clothing.—Translations made for The Literary Digest.

SOAP POWDER.

THE following examples illustrate the ease with which soap powders ad infinitum can be prepared. Wherever possible the combinations should be made without the addition of water. The powders are adaptable to hard water, as their excess of alkali neutralizes the lime that they contain:

Curd (hard) soap powdered	4 parts.
Sal soda	3 "
Silicate of soda	2 "

Made as dry as possible, and intimately mixed.

BORAX SOAP POWDER.

Curd (hard) soap, in powder	5 parts.
Soda ash	3 "
Silicate of soda	2 "
Borax (crude)	1 "

Each ingredient is thoroughly dried, and all mixed together by sieving.

LONDON SOAP POWDER.

Yellow soap	6 parts.
Soda crystals	3 "
Pearl ash	1½ "
Sulphate of soda	1½ "
Palm oil	1 "

—National Druggist.

THE
Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.